1986
Manitoba Swine Seminar

Health and Environment in Swine Facilities

February 19 & 20, 1986

Manitoba Agriculture

86-03774/

A G E N D A

Wednesday, February 19

Chairman:	Dr. M. Sheridan, Veterinary Practitioner, South-East Vet. Clinic, Steinbach, Manitoba
9:15 a.m.	Coffee and Registration
9:45 a.m.	Prevalence and Significance of Swine Respiratory Diseases in Manitoba - Dr. J. Neufeld, Veterinary Services Branch, Manitoba Agriculture
10:30 a.m.	Haemophilus Pneumonia and its Control in Swine Herds - Dr. P. Willson, Veterinary Infectious Diseases Organization and VIDO Swine Technical Group Member, Saskatoon, Sask.
11:15 a.m.	Effects of Minimal Disease Health Status on Herd Performance - Dr. H. Fast, Commercial Swine Producer and VIDO Swine Technical Group Member, Spiritwood, Sask.
12:00 noon	Lunch
1:15 p.m.	Environmental Effects on Swine Health - Dr. S. Curtis, University of Illinois, Urbana, Illinois
2:30 p.m.	Coffee
3:00 p.m.	Environmental Effects on Health of Workers in Swine Confinement Buildings - Dr. K. Donham, University of Iowa, Iowa City, Iowa
4:15 p.m.	Adjourn
7:00 p.m. - 9:30 p.m.	Panel Discussion with Speakers and Informal Reception (Cash Bar)

Thursday, February 20

Chairman:	D. Hodgkinson, Agricultural Engineer, Manitoba Agriculture, Winnipeg, Manitoba
9:45 a.m.	Ventilation of Swine Barns for Healthy Pigs and Workers - Dr. E. Barber, University of Saskatchewan, VIDO Swine Technical Group Member, Saskatoon, Sask.
10:45 a.m.	Behavioural Adaptation of Swine to Environment - Dr. S. Curtis, University of Illinois, Urbana, Illinois
12:00 noon	Lunch
1:15 p.m.	Safety Equipment for Swine Confinement Workers - Dr. K. Donham, University of Iowa, Iowa City, Iowa
2:15 p.m.	Coffee
2:30 p.m.	Use of Computerized Recording Systems in Herd Health Programs - Dr. T. Stein, University of Minnesota, St. Paul, Minnesota
3:30 p.m.	Adjournment and Informal Discussion (Demonstration of PIGCHAMP Computer Recording System)

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PREVALENCE AND SIGNIFICANCE OF SWINE RESPIRATORY DISEASES IN MANITOBA

James L. Neufeld, D.V.M.

There are no easy ways to determine the impact of respiratory diseases on pig production. One can use death loss data, morbidity figures or extrapolate the hidden losses from other research work using reduced feed efficiency or increased days to market. Whatever you use, it is usually expressed in some kind of economic terms. The time period usually adopted is one year.

Two main sources of data were used to gather information for this presentation: 1) The Manitoba Hog Marketing Commission (MHMC) and 2) The Manitoba Veterinary Medical Diagnostic Laboratory.

Condemnations from MHMC data for conditions directly related to pneumonia were used to generate a loss figure for 1985. A total of 1044 hogs were condemned. If an average price of 70 cents per pound is used, this represents $160,776. The remaining data was collected from the files of the diagnostic laboratory, from the 1984 calendar year. Respiratory diseases of significance and the number of cases seen were as follows:

Haemophilus pleuropneumoniae	-	45
Strep-suis type II	-	67
Mycoplasma sp. (Enzootic Pneumonia)	-	103
Pasteurella multocida	-	123
Bordetella bronchiseptica	-	24
Corynebacterium pyogenes	-	37
Strep-suis type II Septicemia	-	83
Inclusion Body Rhinitis (Cytomegalovirus)	-	1
Swine Influenza	-	1

From epidemiologic studies by other workers, it has been determined that there is performance degradation (poor performance) in hogs due to previous or existing infections of the lung.

Type of Disease	Performance reduction in A.D.G. %	Feed Efficiency %
Clinical Pneumonia	5.2	
Pneumonia found at slaughter	1.7	
Bordetella bronchiseptica	16	
Mycoplasma (enzootic) pneumonia	25	20
Natural infection of the lung for each 10% area affected	3-5	

Courtesy Barbara Straw.

Using the laboratory cases and applying the above factors, several estimates of the economic loss to Manitoba farmers were developed. The three most significant diseases were determined to be Haemophilus, Strep-suis type II and Mycoplasma (Enzootic) pneumonia. The other causes of pneumonia were significant in their own right but more often than not, they were found in the same cases as the above three. Therefore, the economics are based on these three main diseases. The price of hogs used in calculating these figures was 70 cents per pound.

Haemophilus pleuropneumoniae

1984 Cases	-	45
Population at risk	-	36,703
Population value	-	$2,584,989
Dead animals	-	380
Deads per case = 8.5		
Value of deads	-	$23,842
Morbidity @ 7% - actual no.	-	2,610
Value of morbidity animals	-	$175,117
Total value (morbidity and deads)	-	$198,959
Cost per case	-	$4,412

Strep-suis Type II

1984 Cases	-	67
Population at risk	-	33,286
Population value	-	$1,775,900
Dead animals	-	536
Deads per case = 8.0		
Value of deads	-	$28,360
Morbidity @ 5% - actual no.	-	1,672
Value of morbidity animals	-	$81,525
Total value (morbidity and deads)	-	$109,886
Cost per case	-	$1,640

Mycoplasma (Enzootic) Pneumonia

1984 Cases	-	103
Population at risk	-	65,442
Population value	-	$4,602,829
Dead animals	-	1,010
Deads per case = 10		
Value of deads	-	$55,223
Morbidity @ 2.7%	-	1,746
Value of morbidity animals	-	$101,249
Total value (morbidity and deads)	-	$156,472
Cost per case	-	$1,519

From this data it can be seen that total "visible losses" are $626,092. However, there are far greater insidious losses from the loss in average daily gain and feed efficiency that was mentioned in the chart above. The losses range from 45 percent with mycoplasma pneumonia down to five percent for clinical pneumonia. For simplicity sake, let us assume the average lowered feed efficiency and loss in average daily gain was 25 percent. If we take the value of the hogs at risk (total of all three) which is nine million dollars and multiply it by 25 percent, we get a value of 2.2 million dollars. Adding the visible loss value of 0.6 million dollars from the above diseases total, we end up with an approximate, calculated loss of 2.8 million dollars annually.

This is very likely closer to the actual losses caused by pneumonia in the Manitoba swine herd. It is likely a conservative estimate, but gives us something to work with. From the figures developed above, the hog farmer can see that it is in his best interest to prevent disease from breaking out in his herd, because it

will cost him from $1,500 to $4,000 in dead pigs and lost efficiency, plus the cost of drugs and veterinary bills.

Pneumonia in Manitoba hogs is significant - has multiple causes; results in significant death and economic losses; and deserves a lot of attention from the prevention standpoint.

Acknowledgements:

The efforts of staff professionals Drs. Swendrowski, Spearman, Austin, Juck and Nayar who worked on many of these cases is greatly appreciated. The technical staff, who assist in the processing of cases through the diagnostic laboratory, contribute many of the skills needed to identify disease pathogens. The secretaries who type the final reports must not be forgotten and are gratefully acknowledged.

EFFECTS OF MINIMAL DISEASE HEALTH STATUS ON HERD PERFORMANCE

Harold Fast
February, 1986

REASONS FOR WANTING A HIGH HEALTH HERD

1. To reduce production costs
   - Feed used/unit of gain
   - Growth rate

2. To reduce the amount of labor and management involved in controlling health problems
   - needling time
   - medicating water and feed

3. To reduce the risk of marketing meat contaminated with antibiotic residues

4. To reduce animal suffering
   - sick pigs
   - treatments

SOME SPECIFIC DISEASES FROM WHICH HIGH HEALTH HERDS ARE FREE

Respiratory

1. Enzootic pneumonia
   - intracellular organism, very difficult to reach with antibiotics
   - common to have more than 80% of slaughter pigs with lung lesions in affected herds
   - a major cause of variable growth rates
2. Haemophilus pleuropneumonia
   - bacterial pneumonia causing symptoms ranging from rapid death to chronic pleuritis
   - poor understanding of control methods
3. Atrophic Rhinitis
   - multifactorial cause, including two strains of bacteria, leading to nasal distortion

Enteric

1. Swine Dysentery
   - bacterial cause of diarrhea, primarily in feeder pigs
   - reasonable success in controlling with in feed medication

2. Salmonella
   - bacterial cause of diarrhea, pneumonia, septicemia
   - can be transmitted to man
   - able to control with in feed medication

3. Porcine intestinal adenomatosis
   - bacterial cause of diarrhea, resulting in acute death to progressive wasting
   - reasonable success in controlling with feed medication

Parasites

1. Mange
   - highly irritable condition leading to unthriftiness and poor breeding

2. Nematodes
   - ascarids

OPTIONS OF ACHIEVING HIGH HEALTH

1. Buy from a High Health source herd

2. Medicated early weaning

3. Ceasarian derived colostrum deprived

4. Ceasarian derived and fostered

The reports in the literature do not always show a drop in performance when a health problem emerges in a herd. Although an improvement in production does occur when a herd is "cleaned up". While this may seem paradoxical, it may be that when a herd is "cleaned up" a number of restrictions are eliminated, while a herd "breaking down", normally does so with one problem at a time.

Below are listed examples of some performance parameters:

Lorne Penner restocked his herd using option 4, ceasarian derived and fostered onto High Health mothers.

Penner's Probe Data

	Before restocking		After restocking		Improvement	
	B.F.	Days	B.F.	Days	B.F.	Days
Hamp. Boars	12.5	163	13.4	135	+ .9	-28
Hamp. Gilts	13.5	167	15.0	142	+1.5	-25
Duroc Boars	12.7	171	15.3	131	+2.6	-40
Duroc Gilts	14.1	165	19.4	136	+5.3	-29

Two Barns - same genetics, feed, similar management - 1985 Production

	High Health	EP + PIA
No. of pigs	1809	3303
Days to Market	151.3	157.6
Average Weight (Kg)	102.0	100.6

Some Parameters from a High Health Herd in 1985

No. of pigs sold (including sows)	1840
Herd Feed Conversion	2.84
Growing Herd Conversion	2.2
Feed Cost/Pig - Grower	42.28
- Starter	15.03
- Sow	12.16
Total	$69.47
Feeder Barn Mortality	0.86%
Nursery Barn Mortality	0.57%
Nursery Barn ADG (gms)	408
Nursery Barn FCR	1.60
End Nursery - Weight (Kg)	20.94
- Age (Days)	57.19
Farrowing Barn Mortality	8.62%

PARITY DISTRIBUTION

Parity	1	2	3	4	5	6	7
Should be (%)	18	17	15	15	14	14	7
Our Herd	33	24	26	10	5	1.5	.5
Our Litter Size-Pigs Born	9.37	9.84	11.43	11.04	11.33	9.33	

The parity distribution pattern indicates the herd is very young with too few sows farrowing with their 3 - 6 litters (11+ pigs born). As a result the number of pigs born/litter is small. We believe the problem is due to the following reasons:

1. Sows were sold to be used as foster mothers.
2. Sows nursing their first, and to a degree, their second litters, experience excessive weight loss.
3. Gilts are selected when weighing for slaughter, resulting in 140-150 day old gilts being moved to the sow barn. At their second cycle, they are commonly less than 180 days of age when bred.

ENVIRONMENT AND HEALTH IN SWINE PRODUCTION*†

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Intensification of swine production has been followed by new challenges in environmental and disease management. Deficiencies in some operations are immediately apparent. However, first appearances can be deceiving. Consider the healthy, productive environment for pigs provided by the lowly ventilated, crowded "sweat house" still used in Ireland. Thus, we must learn more, as well as apply more of what we know and learn, about the ecology and ethology of swine.

ENVIRONMENTAL EFFECTS ON SWINE HEALTH

Direct environmental effects on performance of healthy swine are well-recognized. Most attention has been paid to effects of the thermal environment on survival, growth, and feed-conversion of efficiency (Curtis, 1981, 1982). Some direct pathologic consequences of stresses—such as the porcine stress syndrome (Marple and Judge, 1976), cardiac infarcts (Johansson et al., 1974), and fundic gastric ulcers (Backstrom and Bjorklund, 1974)—have been characterized, too. Hence, the environment can affect swine performance not only directly, but indirectly via influences on health, as well (Backstrom and Curtis, 1981).

A new class of diseases has also arisen: the syndromes of multiple etiology, known also as production diseases or factorial diseases. These diseases are epitomized by the finding that piglets born to specific-pathogen-free sows and kept under environmental conditions classified as poor, fair or optimal, respectively, developed pneumonia, the severity of which depended on environment quality (Kalich, 1970). Clearly, clinical manifestations of infectious diseases of swine can be affected by the microenvironment in which the animals reside.

Health as Harmonious Balance

Swine can function normally only when they are living in harmonious balance with the other living forms and the physical and chemical factors in the environment. Each of these three—animal, biologic environment, and physical environment—affects the others. Thus, when one or more of them changes, imbalances can arise. Such imbalances sometimes lead to abnormal function, a sign of disease. Hence, in the broad sense, the physical and biologic environments and the pig itself—together—are codeterminants of infectious diseases.

More specifically, disease results from the action of a primary pathogenic agent on a given animal in a given environment. Again, three factors—primary pathogenic agent, environment, and animal—combine to determine whether disease

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*As presented at the 1986 Manitoba Swine Seminar, Winnipeg, 19-20 February 1986.
†Largely extracted from "Environment and Health in the Hog House" by S. E. Curtis and K. W. Kelley in Proceedings of the 1983 Pork Industry Conference, University of Illinois at Urbana-Champaign.

occurs or not. The etiology of a specific case of disease--the information necessary to reduce chances of its occurring in the future--is complete only when all three components are considered.

The primary pathogenic agent is itself a part of the animal's environment. It might be a toxic substance, e.g., a noxious gas; a thermal-environmental factor, e.g., solar radiation; or a parasite, e.g., a bacterium, a virus, or a worm. The action of the primary pathogenic agent represents a direct challenge of the environment to the animal's continued existence. The animal resists such challenges with a variety of defense mechanisms, all of which are costly in terms of the animal's energy and nutrient balances. Disease ensues if these defenses are impaired or otherwise inadequate. If the defenses are successful, either disease does not occur or it is eventually defeated.

The other environmental factors combine to influence both the specific primary challenge and the animal's defenses. Either way, in effect, they predispose the animal to the debilitating effects of the primary agent. Via these effects, the total environment influences the frequency and the severity of infectious diseases. Secondary pathogenic agents might be any sort of environmental factor: a living vector can aid in transmitting a pathogenic microbe to a susceptible animal; dust can carry into the lungs an irritating gas that otherwise would have been absorbed in the mucus lining of the upper respiratory passages; cold stress can reduce an animal's defenses so an opportunistic microbe that had been inhabiting the animal without rendering harm during a nonstressful period can fulfill its pathogenic potential.

The equilibrium between an animal and a population of infectious microbes, and the ways the surroundings can affect this equilbrium, are complicated.

First: The Challenges and the Environment

The ultimate source of a microbic agent of disease is an infected animal. The environment transports pathogenic microbes between animals and also determines the microbe's survival outside a host animal. Crowding the animals tends to enhance the spread of infectious agents via direct contact. Environmental management is even more critical in indirect transmission, in which the microbes must survive an environmental excursion with virulence remaining intact to fulfill their mission. The environment affects the challenges of microbic pathogens to swine health (Backstrom and Curtis, 1981). Environmental factors which are important in this respect include: aerial vapor pressure, ultraviolet radiation, and various animate and inanimate vectors (Curtis, 1983).

One critical, often neglected facet of disease management in swine production is basic sanitation. There is striking evidence in favor of a sanitation break in farrowing rooms, for example. In one study, during the 6 months preceding such a break, the incidence of diarrhea in newborn piglets was 33 percent, and deaths from it almost 4 percent; during the first 6 months after the sanitation break, these had fallen to 11 percent and less than 1 percent, respectively (Nielsen et al., 1976). Other researchers depopulated and thoroughly disinfected a farrowing house after collecting data on the last 30 previous litters in a continuous series of farrowings (Pepper and Taylor, 1977). Then they collected data on the first 30 and second 30 litters farrowed in the facility after the sanitation break. Depopulation and disinfection led to markedly improved piglet performance. But there also was evidence that disease

build-up started immediately after the break, suggesting that sanitation breaks should be made as frequently as feasible.

Second: The Defenses and the Environment

It is practically impossible to eliminate stress in animal production. The problem of stress-altered disease resistance must be dealt with continually. Although it is generally agreed that stress influences an animal's defenses against infectious agents, unequivocal quantitative evidence is still difficult to obtain. Indeed, little is yet available, because the phenomenon involves relations among complex entities—environment, immunity, and infectious diseases.

The focus of the rest of this paper will be the effects of environmental elements on the resistance side of the infectious disease teeter-totter. A variety of common environmental stressors—including cold and hot environments, crowding, mixing, weaning, limit-feeding, noise, and movement restraint—are known to alter animals' defenses against infectious microbes (Kelley, 1980). In particular, the susceptibility of swine to specific infections, and the courses and effects of these infections, are known to be influenced by specific stressors (Kelley, 1982).

Pulmonary Bacterial Clearance and Various Stressors

Swine normally can clear bacteria that have deposited in their lungs and thus keep the lungs relatively sterile. Respiratory-tract defenses include alveolar phagocytes and the mucociliary apparatus. However, various stressors—including cold exposure, aerial ammonia, and the migration of ascarid larvae through the lungs—depress pulmonary bacterial clearance processes, presumably predisposing the pigs to pulmonary infections (Curtis et al., 1976; Drummond et al., 1978; Tisch et al., 1980).

Aerial Ammonia and Specific Infections

The courses and effects of respiratory diseases are also influenced by atmospheric ammonia. For example, effects of stresses from ammonia and early ascarid infection on the growth of young pigs were additive (Drummond et al., 1981b). Either condition alone depressed bodyweight gain by around 30 percent; when they were combined, growth rate was reduced by 60 percent, even though the air pollutant did not intensify the liver and lung lesions left by the migrating ascarid larvae. On the other hand, the severity of nasal-turbinate and lung lesions due to infection of young pigs by a pneumotropic strain of Bordetella bronchiseptica was directly related to the aerial concentration of ammonia, but growth rate--which was depressed by the infection alone--was not affected additionally by the ammonia (Drummond et al., 1981a).

Cold Stress and Passive Immunity in Piglets

Piglets are born having a very low blood concentration of antibodies (immunoglobulins). They raise the blood antibody concentration via immunoglobulins from sow colostrum ingested during the first postnatal day. These large colostral-immunoglobulin molecules are localized, internalized, and transported through intestinal epithelial cells and discharged into the blood by way of the lymphatic system. Many of the piglets that die before weaning had blood colostral-immunoglobulin concentrations that were significantly lower than normal a couple of days after birth (Hendrix et al., 1978; Yaguchi et al., 1980).

Furthermore, when piglets are exposed to a cold enviornment and then returned to the sow, they have lower levels of circulating immunoglobulins than do those kept in thermoneutral surroundings (Parker et al., 1980; Blecha and Kelley, 1981a). Subsequent research has revealed that this cold-induced reduction in passively derived serum immunoglobulins is not due to any defect in the piglet's ability to transport immunoglobulins from the intestinal lumen into the blood (Kelley et al., 1982a). Instead, it seems that exposure to a cold environment simply reduces the amount of colostrum a piglet takes in (LeDividich and Noblet, 1981).

Newborn piglets have a high lower critical temperature of around 93°F (Curtis, 1982). They are fragile during the first day after birth, but thermostability improves markedly during the second and third postnatal days (Curtis et al., 1967). The immunoglobulin concentration in colostrum falls in a much shorter period. By 4 to 6 hours after parturition, it is only half that at the start of farrowing (Bourne, 1969). Also, the ability of the newborn piglet to absorb colostral immunoglobulins decreases rapidly with age (Lecce, 1973). Therefore, to obtain maximal blood concentration of colostral immunoglobulins, piglets must nurse soon after birth. If they are cold at birth, they are less likely to nurse vigorously. The result is a lower concentration of colostral immunoglobulins in both the gastrointestinal tract and the blood.

Heat Stress and Passive Immunity

Heat stress during pregnancy has deleterious effects on the passive immunity the sow provides her young (Machado, 1980). Sows were subjected to moderate heat stress during the last two weeks of gestation, but not during or after parturition. The concentrations of cortisol in the blood and in the colostrum of stressed sows were higher than normal, while those of immunoglobulins in colostrum and milk were lower. The significantly lower immunoglobulin concentration in the blood of day-old piglets from heat-stressed sows might owe to higher colostral cortisol concentration, lower colostral immunoglobulin concentration, or both. In any case, piglets born to sows which have experienced heat stress during late gestation apparently have subnormal immunity against certain infectious diseases.

Cold Stress and Infectious Diseases

When 21-day-old pigs were kept at 83°F and infected with enterotoxigenic Escherichia coli, around a third of them developed clinical symptoms of diarrhea (Armstrong and Cline, 1977). But when the pigs were exposed to a cold environment (50°F) and infected, the number that developed diarrhea doubled. Also, the rate of bodyweight gain in cold-stressed diarrheic pigs was a third less than in control pigs.

The susceptibility of pigs to transmissible gastroenteritis (TGE) virus is also increased by cold stress (Shimizu et al., 1978). When 8- to 12-week-old pigs were held in an 86°F environment, they were resistant to TGE virus. But when infected with the virus and held at 39°F, the pigs became highly susceptible to the virus. When environmental temperature fluctuated between 68°F and 39°F, there was a similar reduction in resistance to TGE virus.

It is not known why cold exposure reduces the resistance of pigs to certain infectious diseases. However, there is substantial evidence indicating that cold exposure causes changes in critical hormonal parameters. These endocrine changes might then alter the mechanisms that control the induction or the expression of immune processes. The glucocorticoids, for example, are immunosuppressive when present in the blood at very high concentrations. Such changes in immune function might then alter the immune status of the young pigs, and thus their susceptibility to infectious diseases.

But the picture remains cloudy; the puzzle's parts are not yet together. Since cold stress increases the susceptibility of pigs to certain infectious diseases, it might be expected that the pig's immune defense mechanisms would be affected negatively by cold weather or sudden downward fluctuations in environmental temperature. Paradoxically, it was found that antibody titers to TGE virus were higher in cold-stressed, infected pigs than in infected pigs kept in a thermoneutral environment (Shimizu et al., 1978). This puzzling result led to speculation that the TGE virus simply proliferated to a greater extent in cold-stressed pigs. The postulated greater proliferation of the virus, in turn, would provide a greater amount of antigen to stimulate antibody synthesis, which might explain the higher antibody titers found in cold-stressed, infected pigs.

If cold stress increases the antigenic challenge simply by increasing viral proliferation, it would be expected that the cold would not affect antibody titers in pigs vaccinated with killed vaccines or other nonreplicating antigens. Consequently, experiments were conducted with cold-stressed pigs that were vaccinated with a commonly used nonreplicating antigen, namely, sheep red blood cells (SRBC). Five-week-old pigs were put in a 32°F environment immediately after such vaccination and kept there for 4 days (Blecha and Kelley, 1981b). However, even with this nonreplicating antigen, cold stress caused a 360-percent increase over control pigs at thermoneutrality in titers to the SRBC. Another interesting finding was that the concentration of immunoglobulin in blood increased by 60 percent in cold-stressed pigs. These results indicated that cold stress had direct, stimulatory effects on the pig's ability to synthesize antibodies.

The physiologic reasons for these cold-stress-induced increases in serum immunoglobulin concentration and antibody titer are unknown. But it is clear that cold stress affects antibody-mediated immunity in pigs and other animals, probably by altering regulatory circuits among the particular lymphoid cell subpopulations that control antibody synthesis.

Weaning stress and immune responses. In the experiment just described, it was of interest to learn whether newly weaned pigs were more susceptible to changes in immune responses caused by cold stress than were control pigs weaned previously. Littermate pigs weaned at 21 or 35 days of age were exposed to a cold environment for 4 days at 35 days of age. It was found that cold exposure caused significant increases in antibody titer to SRBC and in circulating immunoglobulin concentration as compared to thermoneutral conditions, regardless of age at weaning. In other words, newly weaned pigs were no more subject to cold-induced changes in antibody immunity than were their littermates that had been weaned two weeks earlier (Blecha and Kelley, 1981b). However, although time of weaning and cold stress did not interact, pigs that were injected with SRBC immediately after weaning at 35 days did have significantly lower antibody titers than did their littermates that were injected at 35 days, but had been weaned at

21 days of age. This change was caused mostly by a reduction in IgM-specific antibody titer to SRBC--a T-cell dependent, B-cell-mediated phenomenon. Clearly, weaning pigs at the time of vaccination can impair their ability to synthesize antigen-specific antibodies.

The reduction of antibody synthesis caused by weaning could be related to changes in T-cell-mediated immune events. New experiments (Blecha et al., 1983a) have demonstrated that the cell-mediated immune response is suppressed by the weaning of pigs before 5 weeks of age: (a) a significant reduction in vitro of both phytohemagglutinin- and pokeweed-mitogen-stimulated lymphoblastogenesis at 24 hours after weaning and (b) a significant suppression of in vivo responses of newly weaned pigs to phytohemagglutinin. Interestingly, when pigs were weaned at 5 weeks of age, there was very little suppression in either type of immune response.

Taken together, these results suggest that: (a) weaning pigs younger than 5 weeks of age impairs T-cell-mediated immune responses, (b) a slight but significant reduction in B-cell-mediated synthesis of antigen-specific antibody occurs when young pigs are injected with antigen at the time of weaning, and (c) effects of cold stress and weaning on synthesis of antibodies are additive. From a practical point of view, it would appear that at least some of the problems in management of early weaned (e.g., 3-week-old) pigs have to do with suppressed immune functions in these animals.

FUTURE RESEARCH DIRECTIONS

Finally, let us take a page from the chicken book again. High social stress decreases the chicken's resistance to Newcastle disease virus, Marek's disease virus, and Mycoplasma gallisepticum, but it increases the bird's resistance to Staphylococcus aureus, Escherichia coli, Northern fowl mite, and Eimeria necatrix (Gross and Colmano, 1969, 1971; Gross, 1972; Hall and Gross, 1975; Gross, 1976). How can these opposite effects be explained? Perhaps social distress elevates blood heterophil concentration, thus enhancing the bird's defenses against bacterial and coccidial infections. Another possibility is differential effects of such a psychosocial stress on various lymphoid-cell subpopulations.

Normal regulation of the immune system is an active, dynamic process, controlled by lymphoid cells which either enhance or inhibit various antigen-specific immune processes. Many cell interactions are involved in the immune response. It has been proposed that the function, differentiation, or perhaps the number of these regulatory lymphoid-cell subsets is affected differentially by environmental stressors (Kelley, 1983). This notion is supported by the fact that certain adaptation hormones alter specific functional immune events at physiologic concentrations in vitro. Also, the relative importances of respective lymphoid-cell subsets depend on the nature of the pathogenic insult present.

Only little is known about the undoubtedly complex mechanisms involved in lymphoid-cell regulation and about how antigen-specific subsets of lymphoid cells become involved in specific infectious diseases. It now appears to be most likely that hormonal influences lie at the center of these regulatory phenomena. If the general notion that hormones affect the differentiation and function of lymphoid cells eventually is proven to be correct, then it will still remain to be learned how different components of the immune system can respond differentially to the same stressor, how the same component can respond differentially to

different stressors, and even how the same component can respond differentially to the same stressor at different times.

Unless and until the results of basic research unlock more secrets about these phenomena, we will not understand the pig's immune system well enough to be able to accurately predict its function under any particular set of environmental conditions.

In conclusion, a wide variety of environmental stressors--including biological, physical, chemical, even psychological stressors—can change an animal's resistance to infectious diseases. Exactly how this happens is not known. The use of basic scientific techniques developed in recent years—coupled with more traditional neurobiological, endocrinological, and immunological approaches--holds much promise for gaining in the near future a better understanding of how the environment influences regulatory signals among lymphoid-cell subpopulations.

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Environmental Effects on Health of Workers In Swine Confinement Buildings

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Manitoba Swine Seminar
February 19-20, 1986

Environmental Effects on Health
of Workers in Swine Confinement Buildings

In recent years, there have been numerous articles in various farm journals about sudden deaths in people and in swine from exposure to high levels of hydrogen sulfide emanating from liquid manure. However, there has been very little written about chronic health problems.

Why does there seem to be such a lack of knowledge about potential chronic respiratory damage in people working in confinement buildings? First, the use of confinement buildings in swine production is relatively new. In Iowa, 90 percent of the buildings have been built since 1970. Also, we found from a survey in 1982, that the average pork producer has been in confinement only 6.2 years. It usually takes 10 to 20 years for most environmental air pollutants to cause chronic respiratory disease. There has not been enough time to see the outcome of working in these buildings for a long period of time.

Another complication in determining environmentally-related chronic respiratory disease is the difficulty in identifying the specific exposure or combination of exposures that caused the illness. There are many substances or practices that are potentially damaging to the respiratory track, such as smoking cigarettes, gasoline fumes, certain pesticides, and grain dust. It is difficult to sort out effects of the confinement building among all of these other exposures.

There is also difficulty in diagnosing chronic respiratory damage. The various ways chronic damage is evaluated are 1) identifying symptoms of chronic lung disease, 2) performing tests on people with a machine that

measures the amount and rate of airflow in and out of peoples' lungs, 3) taking X-rays and 4) performing special techniques to look at respiratory tissue, such as bronchoscopy or lung biopsy. These later techniques are very elaborate and expensive procedures which are only available in a medical specialist's office or a large hospital. Another complication to diagnosis is that there usually is advanced lung damage before the tests are positive and doctors cannot always be sure of just what caused the problem. Therefore, these tests are not frequently done and often are not helpful in detecting chronic disease early.

Another difficulty in diagnosing chronic lung disease from confinement exposure is the lack of familiarity with the problem by physicians. There has been very little written about the problem in medical journals or textbooks, and physicians are not familiar with the potential hazards in swine confinement buildings. Therefore, it is difficult for them to make an association between lung disease and confinement exposure.

There has been very little research done on chronic lung disease related to swine confinement. In fact, our organization, the Institute of Agricultural Medicine of The University of Iowa, has been one of only a few groups in the world that has done or is doing research on this subject. However, recently some studies have been or are being done in Sweden, Holland and Ontario, Canada. We completed our first study in the area of chronic lung disease in the U.S., and I just finished working on a second project in Sweden. Noting all the limitations and difficulties in studying this problem, I will not be able to give many definitive answers at this time. However, I think we do have some information that may be helpful and interesting. I will describe preliminary results of two different studies that we recently completed.

In the first study, we identified 24 confinement swine producers, chosen at random, who volunteered to participate in the study. Each of these individuals was matched with a swine producer who was the same age, and had the same smoking history, but did not work in swine confinement buildings. We compared these two groups using two different types of tests. First of all, we administered a questionnaire to all of the individuals, designed to elicit symptoms of chronic lung disease. Secondly, we used a machine to measure the amount and rate of airflow in and out of their lungs. These latter tests are called pulmonary function tests. We found 55 percent of those people working in confinement buildings had chronic production of excess phlegm and sputum from the throat. We also found that 35 percent of the confinement swine producers had symptoms of restriction of the movement of air in and out of the lungs as manifested by wheezing. Chronic bronchitis and airway restriction were much more common in confinement compared to nonconfinement producers.

The study in Sweden was similar to the one in Iowa. However, it was larger, with 57 workers on 28 different farms. The results of these studies were almost identical to the Iowa study. Chronic bronchitis, wheezing, and work-loss time due to respiratory illness, were very common.

Although these symptoms were definitely chronic, that is, long standing, they do not necessarily mean permanent damage has been done. In many instances, with reduction of exposure to the swine confinement atmosphere, many of these individuals may return to normal within a period of weeks to several months. However, it is known that chronic bronchitis and airway restriction over the years can possibly lead to other permanent diseases such as emphysema. The baseline pulmonary function tests did not show any differences between the confinement and non-confinement swine

producers. This suggests that there was not a great deal of permanent or irreversible lung damage in these people at the time. However, the potential for future lung damage is still evident. Confinement workers who had worked in buildings for greater than six years tended to have worse symptoms, suggesting that the longer people work in the buildings, the greater potential there is for permanent lung damage.

In the second study, we examined symptoms of chronic lung disease in a group of confinement swine producers, and then compared their pulmonary function tests in the morning before working in the buildings and then again four hours later at noon. We found that chronic bronchitis again was the major chronic problem, and it was complicated by smoking. Those people who smoked had more frequent and more severe chronic bronchitis. We also found that the pulmonary functions decreased in most people between the first test in the morning and the repeat test four hours later. This decrease was due primarily to a restriction which developed in the airways, decreasing the flow of air in and out of the lungs. This is probably due to a response of the airways to irritation from gases and particulates in the atmosphere. The irritation causes an excess secretion of mucus and phlegm and constricting of muscle fibers in the airways, which is the body's attempt at protection of the respiratory system. Over a period of several years, this airway restriction, accompanied by the chronic bronchitis could certainly lead to permanent lung damage, such as emphysema. There are examples in other industries such as cotton milling and textile workers where permanent lung damage is initiated from chronic bronchitis and restrictive disease.

In summary, chronic lung disease in swine confinement workers is a very difficult problem to diagnose at this time. Since confinement swine production is relatively new, probably few individuals suffer from permanent lung damage at this time. I feel at this point we have accumulated sufficient data to indicate that there is a greater probability of permanent lung damage in people who have worked for more than ten years in these buildings, particularly if these people happen to be smokers.

The good news in this story is that it's not too late to prevent chronic lung disease from developing in the majority of swine producers! There is a lot of research that needs to be done to provide a better environment inside the livestock confinement building. First of all, ventilation parameters need to be reevaluated; present ventilation rates are based only on removal of moisture and heat produced by swine. We need to consider ventilation rates to control hazardous gases that build up in confinement buildings. We also need to look at new techniques to decrease particulates and gases while conserving energy. We know that ventilation alone will not reduce dust to healthful levels. We need to look at better and improved methods for personal protective equipment, such as respirators. At present, we recommend that everybody wear a dust mask; one that is comfortable to wear, not restrictive to breathing, and easy to maintain. Smokers who work in these buildings should be encouraged to quit. If you have to hire an employee, consider hiring somebody else if they smoke, for their own health.

As I mentioned, I don't think many swine producers have experienced a great deal of permanent damage at this time. However, if we don't answer

the research questions posed in this paper and implement new control measures, we may be seeing a lot of swine producers developing permanent lung disease in the next five to ten years.

With the current political and economic climate, it is doubtful the federal government will supply research funds to answer these questions. We need to look at the private sector to attempt to provide funds for this important research. The Swine Producers and other farm organizations have a stake in this research area. Working together, we have a chance to meet the challenge of raising swine profitably in an environment that is healthful for the swine producer as well as the swine.

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* Denotes peer reviewed journal

THE PIG AND ITS ENVIRONMENT*

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Environmental management has not always been at the heart of animal production. After the glaciers receded and crop production was established, animal agriculture ascended. The animals recruited for domestication by early farmers--the same species farmers all over the world produce nowadays--differed from their cousins that have been left in the wild in that domesticated ones were adaptable to a wider range of environments. Agricultural animals are relatively unfinicky and tolerant. During the thousands of years when farm animals were kept in the natural environment or at best shielded poorly from climatic rigors, the relative ease with which the animals appeared to adapt to their surroundings led husbandmen to give the environment a low spot among the production factors.

The situation has changed greatly during the last 40 years. The advent of widespread intensivism in animal agriculture—together with ever smaller profit margins and our relentless search for ways to raise production efficiency--increased the relative significance of animal-environmental relations. Further, as attempts were made to iron out the seasonal ups and downs in animal productivity, the animals' environmental requirements had to be characterized quantitatively and then accommodated optimally.

The advantages of more regular flows of animals and animal products to market made major environmental modifications economically feasible, and even profitable in many cases. Now, in addition to increasing the genetic fit of animal to environment, we try to meet the animal's needs by modifying the several facets of its surroundings.

An environmental adaptation is any functional, structural, or behavioral trait that favors an animal's survival or reproduction in a given environment. It is the category of adaptive response mentioned last--the behavioral--that we shall focus on in this paper. We shall first discuss the pig's behavioral needs, the design of animal equipment, and optimizing environmental control in animal houses. Then several experimental studies of the pig's behavioral adaptation conducted recently at the University of Illinois will be discussed.

SELECTED NOTIONS ON THE PIG'S BEHAVIORAL ADAPTABILILTY

Behavioral needs

Given a pig's various needs, then the nature of the surroundings, taken as a whole, determines whether those needs can be met. Abraham Maslow's popular theory of motivation in humans is based on the idea that our needs are arranged in a hierarchy according to relative priority. More potent needs dominate us

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*As presented at the 1986 Manitoba Swine Seminar, Winnipeg, 19-20 February 1986.

until they have been satisfied; then, in turn, the less potent ones arise and become motivational forces.

By analogy to Maslow's scheme, a pig's needs might be organized along the following lines, from the lowest, most basic, to the highest: the physiological needs, the safety needs, and the behavioral needs. A great deal is known already about the pig's physiological needs--feed, an appropriate thermal niche, and so on--and as now understood these needs are, for the most part, being fulfilled. In practice, the safety needs are tended somewhat less rigorously than are the physiological, even though laxity in this respect can result in physical injury and even death. Weather accidents, predation, and inadequately designed equipment and facilities still take their tolls. But perhaps even less well-tended are the pig's behavioral needs: "perhaps" because the world's leading thinkers in animal ethology have not yet reached consensus as to whether animals actually have behavioral needs or not. We shall proceed assuming behavioral needs exist, but we must recognize that this fundamental assumption remains tenuous.

Any instance of suffering on the part of a pig due to human action or inaction falls into one of three categories, according to Roger Ewbank: abuse, neglect, or deprivation. Abuse and neglect occur infrequently on today's farms. Deprivation, on the other hand, involves denial of certain, often less vital aspects of the environment. And it is the form of cruelty--if we can use that strong a word--which is most difficult to assess. Many of the needs in the deprivation class would be behavioral, and few have been ascertained, let alone characterized well enough to be of use in designing swine houses. Their presence would be signalled by the pig's demonstrations of frustration, fear, discomfort, or some other such mental state.

Barry Hughes, a poultry behaviorist in the United Kingdom, has proposed a unitary model of motivation which might be applied usefully in the assessment of agricultural animals' behavioral needs. He suggests that every behavior pattern in an animal's repertory lies at a specific point in a continuum of the ratio between external and internal contributions to the causation of the behavior. This continuum can be partitioned into three regions for the sake of discussion. Illustrative examples will involve the laying hen.

In Category 1, environmental stimuli of behavior are far more important than internal motivators. For example, escape and fighting behaviors almost always come in response to predicaments in which an animal finds itself.

Category 2 includes behaviors to which both internal and external factors contribute significantly as triggers. For example, the hen's sexual crouch depends on a distinct releaser in the environment (namely, the approach of a male) as well as an appropriate hormonal state. And dust-bathing (or at least phantom dust-bathing) occurs, but at a lower frequency, in many hens even when they are in a relatively barren environment.

Finally, in Category 3 are those behavior patterns for which internal factors are the chief releasers. For example, hens peck and try to build nests

almost anywhere. Examples in the sow might be: 1--escape, 2--standing heat stance, and 3--maternal nest-building.

Hughes suggests that, to ensure animal well-being, it is desirable to provide for some of the behavior patterns in Category 2, and that it is essential to provide for all of those in Category 3. The decision as to whether it is desirable for a Category 2 behavior pattern to be accommodated by environmental manipulation depends on the relative contributions of external and internal factors to the release of that particular behavior. Those patterns that surface with little or no environmental stimulation should be accommodated.

Obviously then, before any behavior could be designated a need, the animal would need to be subjected to careful, thorough behavioral analysis in the very environment of interest. Moreover, to establish well-being, it is not necessary that an animal's behavior be the same in some environment of interest as in another one arbitrarily set as the standard.

Mike Baxter, of the Scottish Farm Buildings Investigation Unit, has pointed out, in this last regard, that although "performance of behaviour by an animal will simultaneously accommodate its requirements for both agricultural productivity and animal welfare . . . . productivity and welfare are the outcome of 2 separate behaviour subsystems, concerned with the function of behaviour and the control of behaviour, respectively. Thus to describe animal requirements as the need to perform normal behaviour is an oversimplification." He goes on to say that sometimes both productivity and welfare can be accommodated without the animal's ever performing some certain behavior.

With reference to nesting behavior in the sow before farrowing, for example, Baxter suggests that its productive functions (protecting piglets from cold and from being crushed by the sow) could be replaced by appropriate husbandry techniques, while its welfare function (postulated by Baxter to be furnishing the sow's highly sensitive udder a comfortable contact surface) might be achieved simply by providing a comfortable floor. Consequently, the absence of nesting behavior in a prepartal sow would not necessarily mean she were suffering from behavioral deprivation. It might mean merely that this behavior is in Hughes's Category 1 or 2, and that environmental manipulation has eliminated the releaser of the behavior (uncomfortable floor) as well as the usefulness (piglet protection and udder comfort).

Equipment design

Various genetic strains may be differentially adapted to various production environments, resulting in genetic-environmental interactions. But there do seem to be limits to fitting animals genetically to artificial environments. The environments must be designed to fit the animals, too.

Dozens of trade shows each year display animal production facilities and equipment. For any device, the variety of designs on the market is wide. This suggests that (a) agricultural animals are plastic creatures and able to adapt

to a wide range of environments, so some design differences are not significant in terms of animal health, performance, or overall well-being, although they might be in terms of economics, and (b) some manufacturers ignore important knowledge of animals' environmental requirements.

Standards are needed for the design and manufacture of equipment and facilities used in animal production. Most other classes of products farmers use--seeds, feed additives, antibiotics, biologicals, to name a few--have stronger histories of scientific research and development. Indeed, farmers now expect scientific documentation of manufacturers' claims of effectiveness for these products. Still other industries have founded voluntary programs of standards establishment and product testing--including electrical devices, milking machines, and farm tractors. Multidisciplinary teams should establish initial standards for animal equipment now, and at the same time mount more energetic research programs to better describe the various animals' requirements and development programs to learn how to fulfill the requirements.

An outstanding research and development program focusing on layer-cage design is flourishing under the direction of Ragnar Tauson, animal scientist at the Swedish University of Agricultural Sciences. It was established largely in response to pressures from animal welfarists, but the egg industry has reaped large dividends, too. Several parameters are evaluated in relation to specific cage-design features. These include various aspects of the hens' external condition, behavior, health, and egg production: egg quality: operating reliability: and economic considerations.

The work has occurred in three stages so far. In Phase 1, major pluses and drawbacks of specific features of the most common basic designs were identified in three years of testing. Significant differences among designs were found for accidental trapping, external condition, feed wastage, external egg quality, and technical reliability. These findings were used to develop improved design features, which were incorporated in several generations of experimental cages assessed in Phase 2. The various modifications quickly resulted in obvious improvements in the parameters monitored. In fact, the second phase was so successful that it was clear that most of the benefits of this approach had been achieved in only three years. Cooperation and collaboration with major cage manufacturers commenced during Phase 2, and has grown progressively stronger ever since. Phase 3 involves a search for unconventional solutions to remaining cage-design problems. The basic research being pursued in the third stage is slower and more costly, partly because, in the cage designs developed in Phase 2, some of the original problems occur at such low frequencies that it will be difficult to decrease them further. Indeed, they may stand at irreducible minima already.

Unfortunately, Tauson's program has been unique. For other pieces of livestock and poultry production equipment, until six months ago, no one had embarked on Phase 1, let alone Phase 2 or 3, employing such an integrated, holistic, effective approach. Feeders, farrowing crates, gestation crates--these and other items of swine equipment deserve the same attention the Swedish scientists are giving the laying hen's cage. A project funded in part by the

National Pork Producers Council has been started recently at the University of Illinois. Its focus is the farrowing crate. We are also studying the sow feeder.

Our approach to farrowing-crate design

Although sows crush or savage fewer piglets in crates than in pens, today's total preweaning mortality rate remains similar to that 25 years ago when pens were in vogue. Farrowing crates or certain of their specific design features might have deleterious effects on sows, piglets, or both.

From the Swedish evaluations of the laying hen's cage, we know that small design differences can affect both animals and production markedly. But there have been neither scientific evaluations of various farrowing crates nor scientific confirmations of alleged benefits of specific design features. Results of controlled farrowing-crate comparisons simply have not been available to pork industry decisionmakers.

A theoretical framework for the design of farrowing environments has been developed by Seaton Baxter. With regard to spatial analysis, Baxter identifies three zones--(a) a safe zone for piglets, (b) a piglet-sow interaction zone, and (c) a sow zone--and discusses their implications regarding total farrowing environment design. But by no means is our basic knowledge in this area now adequate to the task of designing the ideal farrowing environment a priori. We are just now beginning to gain a quantitative notion of the animals' specific requirements in each zone.

At the University of Illinois, animal scientists are collaborating with specialists in agricultural engineering, agricultural economics, and veterinary medicine in a thoroughgoing examination of the farrowing crate that began in the summer of 1984. Design features being evaluated include: lower bar--straight, bowed, fingered; height of lower bar--8 and 10 inches; width of sow zone--22 and 24 inches; back-gate design, which in effect determines length of sow zone--6 and 6.5 feet. The floor is the same across crate models--plastic-coated expanded metal.

Productive performance parameters being measured include sow weight in and out, number of piglets born alive and dead, birth weight, age at death, cause of death, number weaned, and weaning weight. All health observations and medical/surgical treatments are being registered and taken into account, including lesions on sows in and out and on piglets at specific ages. Also, immune-function tests are being conducted. Behavioral observations, made both directly and via videotape recordings, are being made on adequate samples of animals and include sows' reactions to crates upon introduction: sows' maintenance activities, including postures, phantom nest-building, and parturient behavior; piglets' time to first suckle; piglets' suckling behavior, including assembly at udder; and physical interactions between piglets and of piglets and sows at times other than nursing. Ergonomics observations include herder safety records, objective evaluations of different crates by herders, and time required to perform standard tasks, such as collecting all piglets. Maintenance requirements are being determined from detailed records of all

maintenance efforts and assessments of crate condition at the end of every farrowing cycle. Production economics will be analyzed completely at the end of the project.

During phase 2 of the Illinois farrowing-crate project, problems which persist in the prototype crate(s) developed on the bases of phase 1 results would be identified. Future objectives are (a) to determine the behavioral, physiological, or design features contributing to these problems and (b) to develop and test features designed de novo to reduce these specific problems.

Optimizing environmental control

We also need to learn more exactly how much environmental control is needed in swine production systems. It now appears that some environments are controlled within more narrow limits than is necessary, which can be costly.

The precise limits of experiences which give animals pleasure or displeasure, comfort or discomfort, pain or the absence thereof, remain unkown. The amount of stress a pig perceives apparently depends not only on the intensity and duration of the environmental impingement, but on the animal's psychological and physiological states, as well. Consider the following ideas:

1. When the environment is more controllable or at least more predictable, animals tend to feel more comfortable, even when responding to stressors. On the other hand, when the environment is neither predictable nor controllable, they may become frightened or anxious, and eventually they might assume the state of helplessness and suffer its various consequences.

2. Alliesthesia must be considered, too. This is the situation in which an animal's internal bodily status can markedly influence its perception of the surroundings. In other words, it might be that, before a pig can appreciate warmth, it must have experienced cold.

3. Environments sometimes contain features that give animals the opportunity to cope--to alleviate stress--by engaging in adjunctive activities when they are frustrated, have unfulfilled expectations, or lack control over their environment.

4. Some animals able to control the environmental temperature by themselves inject a large daily cycle--as much as 20 F°--suggesting that, for example, thermal surroundings young pigs find relatively comfortable at midnight would feel uncomfortably cool to the same animals at midday.

Influences such as these four make it all the more difficult to identify the complex of environmental conditions that would ensure the well-being of a particular animal all the time. Moreover, how wise are pigs? Do their wants correspond closely to their needs? What goes on in a pig's mind?

Mental activities cannot be measured directly, but pigs probably have at least some of the same features of consciousness as humans. Still, it is

doubtful that swine are consistently capable of making decisions based on conscious conceptions of the consequences. Therefore, results of experimental choice tests, conducted as means of letting animals identify their preferences --their wants, if not their needs--for themselves, must be interpreted carefully. From choice-test experiences with various domestic animals in the past few years, several points emerge:

1. Expressed preferences are relative among the choices available, and give no idea as to the absolute properties of any of the choices.

2. Choice-test preferences are greatly affected by the animals' previous experiences.

3. The form of the choice test can markedly affect the results.

4. Animals do not always choose rationally with respect to a choice's long-term consequences.

5. A choice made infrequently might nonetheless be very important to the welfare of the animal.

Despite the limitations of choice tests for determining animals' needs, an exciting approach to environmental control is now being studied in several laboratories around the world. It turns out that giving animals operant control of important features of their own environments--things such as feed, temperature, or lighting--might be a practical means of fulfilling the animals' needs and wants, while at the same time sometimes economizing on production resources. Such an approach presumably also increases the animals' sense of control in surroundings which fluctuate in both time and space, sometimes unpredictably and even irrationally. Thus, it might have secondary benefits, too.

STUDIES OF THE PIG'S BEHAVIORAL ADAPTATION

What are we learning about the pig's behavioral adaptability? What are we learning about possible behavioral needs of the pig? Following are brief discussions of results of five experimental studies we have conducted at the University of Illinois recently. Collaborators have been Richard Balsbaugh, Temple Grandin, James McFarlane, John McGlone, Gerald Morris, Tina Widowski, Ian Taylor, and Robert Hurst, all graduate assistants in the Animal Sciences Department; William Greenough, Professor in the Psychology Department; Joseph Simon, Professor in the Veterinary Pathobiology Department; and Edwin Banks, late Professor in the Ecology, Ethology, and Evolution Department.

First: Hide areas

When pigs which are strangers to one another are put together, they invariably engage in a series of one-on-one fights in order to organize themselves socially. The goal in all this is desirable: social orders lead to efficient use of limited resources, such as accesses to feed and water. But

energy is wasted and the pigs can injure one another in these skirmishes.

We simply provided places for a pig to stick its head when it wanted to retreat from the fray, to submit unmistakably. These hide areas were holes cut in one of the pen's walls. The newly grouped pigs did use them, with the result that attack duration in groups of four was reduced by 42% during the first 30 minutes after grouping, and by 35% over the first 90 minutes.

Pigs newly grouped at weaning time in hide-equipped pens experienced a 46% reduction in wound area, a 10% increase in weight gain, and a 24% increase in feed-conversion efficiency during the first seven days. By 21 days, similar trends existed in the performance traits, but they were not statistically significant. The relief the hide areas apparently provided during the first few days after grouping might nevertheless yield benefits in terms of disease resistance in some environments, not to mention the reduction in any psychological distress that might accompany this sort of social tension.

Second: The need to turn around

Gestation crates have clear benefits for sows and gilts. But they do limit the animals' ability to move. Sows can walk no more than a step or two in most crates, and they are ordinarily unable to turn around. This last point is of interest because it has been held by animal welfarists that turning around is a behavioral need of swine. If it is so, then deprivation in this regard might have negative effects on the health, performance, and overall well-being of pregnant gilts and sows.

We have studied the behavior of mated gilts in specially designed turn-around crates--flared at one end to permit the gilt to turn around--to learn whether the opportunity to do so is a behavioral need of this animal.

Two pairs of turn-around crates were used. One pair measured 22" across the center section, while the others were each 24" wide. Each crate was 7' long and covered the same floor area as a standard gestation crate nominally 22" x 7' or 24" x 7'. The space at the flared end of a crate permitted the gilt to turn around at will.

Mated gilts were given a four-day adjustment period to learn by themselves how to turn around. During this time the feeder was located at the pointed end of the crate, the nipple waterer at the flared.

After the adjustment period, feeder and waterer locations were arranged in accordance with one of four permutations: (1) both feeder and waterer at flared end; (2) both feeder and waterer at pointed end: (3) feeder at flared end, waterer at pointed; and (4) feeder at pointed end, water at flared. The four permutations were imposed for six days each.

Feeder/waterer location did not affect the number of turns a gilt made. On the other hand, gilts in 22"-wide crates turned less often than did those in 24"-wide crates--10 times a day versus 14. Most likely, they found it more

difficult or less comfortable--although still possible--to turn around in the narrower crate. Turning frequency was not influenced by any other independent variable studied. These results suggest that the gilts were motivated to turn around by one or more factor(s) other than, or at least in addition to, merely feed and water locations.

In order to establish turning around as an essential behavioral need requiring accommodation by the environment, according to Hughes's approach, a more thorough behavioral analysis would be required. In the first place, it would need to be proven that depriving pregnant gilts of the opportunity to turn around leads to distressful frustration; that is, that the pregnant gilt cannot in some way cope adequately with the absence of the opportunity to turn around so as to preserve a satisfactory sense of overall well-being. The fact that narrowing the crate form 24" to 22" reduced the frequency of turning around by over 25% suggests that, if turning around is a behavioral need at all, it is not a strong need.

Third: Piglets intoxicated by carbon monoxide

Carbon monoxide (CO) from improperly functioning fuel-fired heaters of all sorts is known to build up in some farrowing houses, especially when ventilation rate is inadequate. The result can be a marked increase in the stillbirth rate without any apparent infectious cause.

We learned that, in addition to the lethal effects of CO on fetuses and newborn piglets, those born where the atmosphere contains CO at high, but sublethal, concentrations behave in some ways that indicate they are less vigorous and perhaps more prone to succumb to the rigors of early life after birth:

(1) At background concentrations of CO, piglets on average began to nurse 50 minutes after delivery, whereas those at 250 ppm did not begin nursing until an average of 72 minutes after delivery.

(2) Piglets prefer to head up an incline rather than down a decline. The negative-geotaxis test measures a piglet's response time to facing down a 15° slope; i. e., how long is required for the piglet to turn around and face up the slope? At both 24 and 48 hours after delivery, piglets in an atmosphere containing CO at 250 ppm were much more sluggish than normal in the negative-geotaxis test.

(3) The open-field test measures a piglet's general activity in a strange environment, among other things. We simply counted the number of floor squares a piglet entered during a three-minute period in the field. The piglets under CO at 250 ppm entered less than half as many squares as did their background-control counterparts.

Fourth: Environmental complexity

Are pigs receiving an adequate amount of environmental stimulation in certain modern systems of pork production? Are they bored? We are exploring possible objective ways of measuring effects of environmental complexity on the behavior and central nervous system development of young pigs. Until such methods are available, questions as to whether the pig experiences distress due to understimulation in certain production settings which may strike us as being monotonous, cannot be answered in scientific fashion.

In our study, the supposedly simple experience consisted of pairs of pigs being held in 4' x 4' nursery pens. Light intensity and environmental temperature were kept constant. These pigs were not handled except for routine feeding and pen-cleaning every third day. The supposedly complex experience consisted of twelve pigs being held together in an outdoor pen with an adjoining house bedded with straw. These pigs were handled and played with by the experimenter for at least 15 minutes daily. They were also provided various objects with which to play: milk crate, cloth strips, garbage can, rope, twine, newspaper, dirt, stone, and beverage can, among other items; some were changed daily.

At the end of a 9-week existence in one of the two environments, each pig was tested to determine the time required for it to approach an unfamiliar man and a novel object, respectively. Each pig was placed individually in a small novel pen in which there was either the man or the object. Pigs from the complex environment approached both the object and the man more quickly than did their counterparts from the simple environment: pigs from the complex environment approached the man in 60 seconds, the object in 50; and from the simple environment, approached the man in 100 seconds, the object in 84.

As for central nervous system measurements, it is known that rats raised in an enriched, stimulating environment have greater cortical depth in the brain as well as greater dendritic (i. e., nerve-fiber) branching in the visual part of the brain's cortex, compared to those in rats kept in pairs or individually in standard laboratory cages. The purpose of this part of our study was to determine whether the changes observed in rats would also occur in pigs, and thus whether the changes might serve as an objective measure of the relative stimulation level of different swine production systems.

The pigs were slaughtered at the end of the 9-week trial. Four different measurements were made on the pigs' brains. Brain weight and dimensions were measured in half of the pigs, while brain cortical depth and nerve-fiber branching were measured in the rest. Cortical depth and dendritic branching were measured in that part of the brain's somatosensory cortex corresponding with the end of the snout. This area was chosen for our initial investigation because the pig explores its environment mainly with its snout, and a large part of the pig's brain is devoted to receiving sensory input from the snout.

There were no differences between pigs from the two environments for either weights or dimensions of the brain's cortex or cerebellum. The medulla was slightly heavier in complex-environment pigs, but not significantly so. Thus, brain weight and dimensions were crude reflectors of any environmental differences perceived by the pigs.

Stimulatory effects of environmental complexity on the pig's central nervous system remain obscure. Environmental complexity probably has different effects on different parts of the brain, and we are studying this possibility now.

We continue to study effects of environmental stimuli such as toys and human interaction on the subsequent behavior and performance of pigs of all ages.

Fifth: Operant supplemental heat

Operant conditioning occurs when an animal learns that, by operating something in its environment, it receives a reward. Operating a nipple valve to gain a water reward is a common example of operant behavior in the hoghouse. Pigs know about the weather, too. And it has been known for quite awhile that individual pigs will operate a switch to gain a heat reward in rational fashion. Several years ago, we conducted a series of experiments in controlled-environment chambers and learned that (a) pigs in groups would do likewise, as they shared heat-switch-operation duties, and (b) even under constant air temperature, they called for radiant supplemental heat twice as often in the early afternoon as in the early morning.

This latter finding of the pigs' demand for a warmer daytime environment was interesting, and was confirmed when the pigs were observed to operate a switch turning uncomfortably warm heat lamps off twice as often at night as in the afternoon.

We were encouraged to conduct a performance experiment. Two rooms in the same nursery were operated with either thermostatic (setpoint = 80°F) or operant supplemental heat control. Heat was generated by gas-fired unit heaters. In three trials, consistently, the weanling pigs called for an early-afternoon high air temperature around 80°F, and an early-morning low around 60°F. The fuel savings amounted to more than 50% over the three trials. Pig performance was comparable in the two environments. The application of operant heating in swine houses would seem to be something that ought to be pursued. At the very least, this is just one more example of letting pigs express their preferences by their behavior. Preference-test pitfalls notwithstanding, it looks as if daily temperature cycles in hoghouses may well be profitable.

VENTILATION FOR HEALTHY PIGS AND WORKERS

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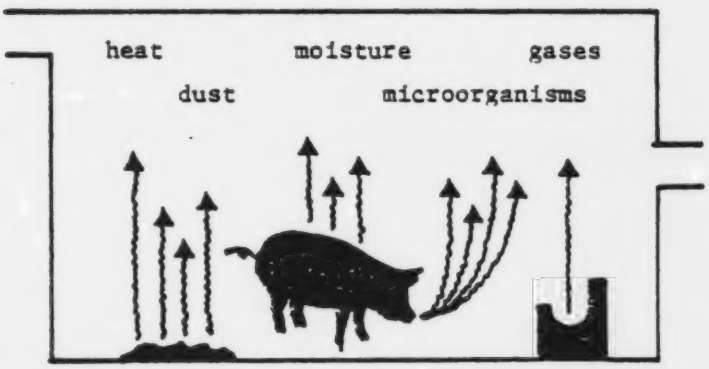
Ventilation is required in any building used to house pigs. How well a barn is ventilated will have a large influence on the health and productivity of the pigs. Furthermore, the respiratory health of the barn operator is at stake.

This paper will outline why pig buildings need ventilation. The relationship between ventilation and other aspects of building design will be explained. The concepts of minimum continuous ventilation, under-floor air exhaust, filters and air cleaners, and room air mixing systems will be discussed.

WHY VENTILATE

A normally-functioning pig, whether kept outdoors or in a barn, must continuously give off heat, moisture and carbon-dioxide. In addition, pigs shed microorganisms and skin particles (dust) into the surrounding airspace. When a pig is kept outdoors, all of these noxious contaminants can freely move away to be diluted by the atmosphere. But in a confinement building, these same contaminants will accumulate unless provision is made for their removal. The problem is aggravated by dust from the feeding system and by moisture and gases (eg., ammonia) released from manure stored within the building.



Contaminants within a confinement swine barn

Ventilation is the passage through an airspace of clean fresh air so as to dilute the contaminants in the airspace. The replacement of stale air by fresh air also replenishes the oxygen needed by the pigs. In a natural ventilation system, air moves in and out of the building under the forces of wind and temperature gradients. In mechanical ventilation systems, fans are used either to blow fresh air into the barn, forcing stale air out through outlets (called a positive pressure system) or to blow stale air out of the building, creating a suction to cause fresh air to enter through air inlets (called a negative pressure system).

ACHIEVING UNIFORM AIR DISTRIBUTION

Regardless of the equipment used to ventilate a building, it is important to understand that ventilation occurs primarily by mixing and dilution rather than by displacement. When water moves through a hose, each unit of water pushes its way through the hose as an intact plug, forcing ahead of it anything already in the hose. If both ends of a pig barn were completely removed, a similar process would occur. However, when the ventilation air is forced to enter and exit through a relatively more restricted inlet and outlet, the plug flow action is destroyed. The fresh incoming airstream soon gets separated and fresh air is mixed with room air until neither fresh nor stale air can be recognized separately. Stale air leaving the ventilated airspace is a mixture of air, some of which has been in the building for only a few minutes, and some of which may have been in the airspace for several hours.

Ventilation is a dilution (left), not a displacement process (right)

Because of the mixing that takes place between fresh and room air, an entire airspace can be kept at a nearly uniform temperature. But just as heat is evenly distributed throughout the airspace, so too are moisture, gases and microorganisms. Pathogens shed by a sick animal can be spread throughout the entire airspace. Because contaminants cannot be removed out of the building without first mixing into the entire airspace, it is extremely important that the levels of these contaminants all be diluted to low enough levels so as not to cause health problems. This is also why it is a good idea to remove very sick animals from the main airspace so that the risk of infecting other animals is reduced.

Several authors (eg., Moreland, 1975) have recommended ventilation systems that deliver fresh air to each animal pen and remove stale air from each pen without any cross contamination between pens. While such systems can be designed and are sometimes used in laboratory animal facilities, there is not presently any practical means to achieve isolation of pens contained within the same airspace in a commercial pig barn. Airborne organisms will move from pen to pen in even a very still airspace. Attempts to reduce cross-examination invariably lead to stagnant areas in some pens and drafty conditions in other pens. Deliberate stirring or mixing of the airspace such as by recirculation of room air is recommended whenever uniform temperatures throughout the airspace cannot otherwise be maintained.

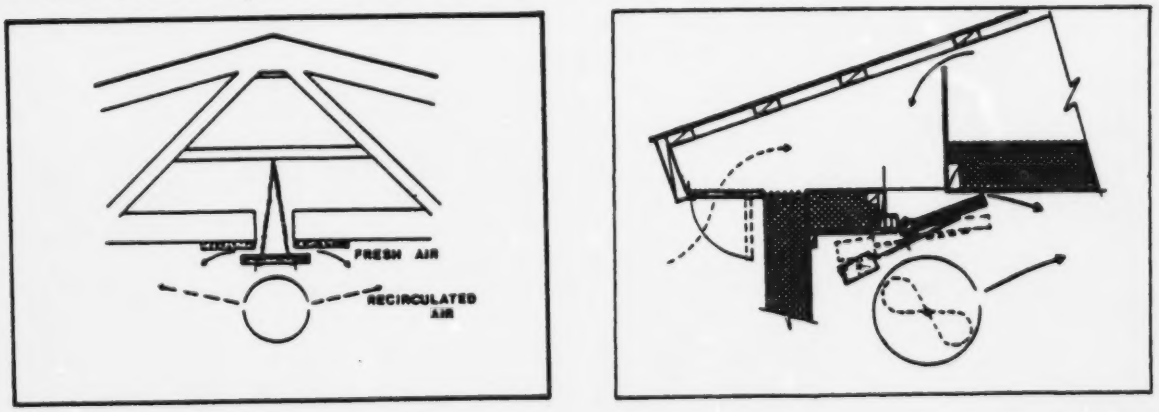
Kolacz et al (1982)(compared weanling pig performance in a triple-deck battery system. Consistently, the best environmental conditions were in the top deck and the worst conditions were in the bottom deck. Weight gain and physiological blood indexes were adversely affected in the bottom deck.

MICROCLIMATE IN TRIPLE-DECK WEANLING CAGES

Cage Level	Air Velocity	RH	Temp	Gain (g/d)	Mortality (%)
Top	High	Low	High	423	1.3
Middle	Low	Med	Med		2.8
Bottom	High	High	Low	396	3.7

Kalacz et al, 1982

In another recent study of triple deck battery cages, Veit et al (1985) found that weanling pig performance was not affected by position within the deck. However, in their experiments, an auxilary room air mixing fan was used. Gorman and Barber (1985) showed that only a small amount of air mixing will remove any differences in ventilation rate from location to location within a room containing double-deck weanling pens. A good current recommendation is to provide an auxilary mixing fan or a recirculation fan that will move a quantity of air about three times the minimum winter ventilation rate. Any higher recirculation rates may lead to drafty conditions and will not further improve the uniformity of airspace mixing.



A good air recirculation system for swine barns

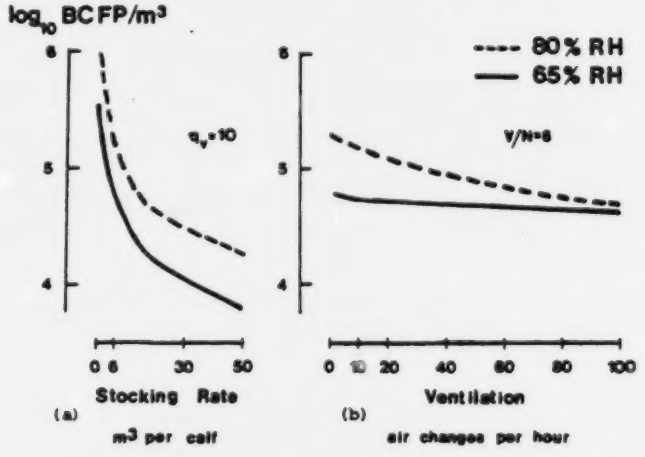
BUILDING DESIGNS THAT SIMPLY AND HELP VENTILATION

Animal Density

A recent Australian survey (Pointon et al, 1984) of herds with and without a high prevalence of enzootic pneumonia identified several key differences in the herds. A high prevalance of disease was associated not with differences in temperature and relative humidity but rather with:

(a) a smaller room airspace volume per pig,
(b) a larger number of pigs per room,
(c) a larger number of pigs per pen,
(d) drafty farrowing and weanling accomodation,
(e) a higher sow culling rate (lower average age of sows),
(f) the off-farm purchase of pigs for finishing, and
(g) higher ammonia levels in summer.

English researchers (Jones et al, 1982) working with calf barns have demonstrated that increasing the room volume per calf decreases the survival of airborne organisms. Decreasing the number of animals sharing the same airspace has a much more dramatic effect on reducing airborne organism counts than increasing the ventilation rate. Minnesota experts (Anderson et al, 1978) likewise have begun to specify animal densities in terms of room volume per animal.

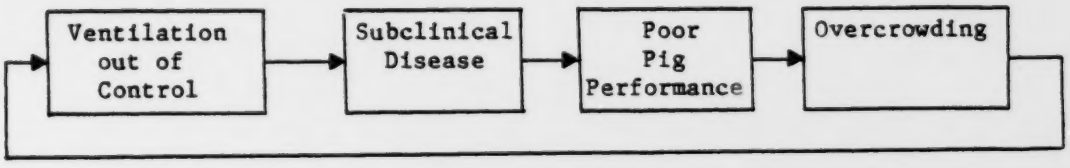


Predicted effects on airborne organisms in a calf house of varying stocking rate versus increased ventilation (from Jones et al, 1982)

In Saskatchewan, there has been a general trend in recent years to building swine barns (and poultry and dairy barns) with higher ceilings. Ten feet between floor and ceiling is recommended. In addition to reducing airborne organism counts, the high ceilings give more flexibility in placing overhead equipment and air ducts.

Swine producers also should consider keeping pen group sizes small (less than 20 for grower-finisher pigs and less than 10 for weanling pigs). Prevention of nose-to-nose contact between pens is desirable but usually difficult to achieve in practical buildings. The number of pigs sharing a common airspace should be limited. In the case of finisher barns, keeping more than 500 pigs in a single room is not recommended (Morrison and Morris, 1985).

Feeder barns should never be crowded. A typical scenario, especially associated with farrow-to-finish operations, is outlined in the sketch wherein poor performance of a batch of pigs leads to overcrowding and a spiralling decrease in pig performance. Excess weanling pigs should be sold rather than crowding a finisher barn.



EFFECT OF OVERCROWDING IN A FINISHER BARN
(Adapted from Paton, 1982)

All-in-all-out Room Management

Whenever the overall size of the pig operation is large enough to make room sizes practical, all-in-all-out is preferred to continuous stocking of all phases of pig production. There is a considerable body of evidence pointing to decreased disease and increased performance with all-in-all-out farrowing, weanling, and finisher barns. (VIDO, 1981; Le Dividich and Aumaitre, 1978).

	Continuous	All-in-all-out
ADG(g)	400	503
Feed/Gain	1.89	1.74

Schneider and Bronsch, 1973 in Le Dividich et al, 1978

In some laboratory facilities, all-in-all-out implies complete isolation of adjacent animal rooms. Such isolation should not be attempted on practical farms. Firstly, the airborne particles that are involved in disease transmission are very small (diameter less than 5 um) and can very easily drift between barns on the same farmstead, even when wind speeds are very low (Baxter, 1984). Secondly, if pigs are going to be moved through several rooms during a lifetime, then it is not desirable that the rooms be immunologically different (Jensen et al, 1978).

The purpose of all-in-all-out systems is not to completely isolate the different groups and segments of the production cycle. Rather, the objectives are to:

(1) simplify pig management and record keeping

(2) enhance the ability to break disease cycles by completely cleaning out rooms periodically; and

(3) enable the maintenance of different climatic environments (eg., temperature) in adjacent rooms housing pigs of different ages.

Monitoring and Record Keeping

Paton (1982) outlined the essential features of a minimal on-going monitoring program for swine barns.

(1) Monitor production closely to catch little problems before they become big problems.

(2) Monitor condition of animals, including rough coat, huddling, lying in pen corner, etc.

(3) Place confidence in first impact of a new visitor - you can become acclimated to a steadily worsening condition.

(4) Watch for dangerous gases.

(5) Monitor condition of fans, controls, and inlets.

His system recognizes that an operator can miss important changes in environment or production when the changes occur very slowly over a long period of time. When a problem does occur, very often the professionals called in to make recommendations are severely hampered by a lack of background information and records. The most appropriate remedy for a production or disease problem cannot be specified unless the exact cause of the disorder is known. Keep at least simple records on production, disease, environment, and building condition if for no other reason than to assist the people who you call in to give you advice when you get into trouble.

SPECIFYING OPTIMUM VENTILATION RATES

To be effective, a ventilation system must dilute not just one, but all noxious contaminants to low enough levels. Specifying a required ventilation rate, then, must start with identifying the contaminants and specifying an appropriate maximum concentration for each in the airspace.

Optimum Relative Humidity

Recently, engineers have argued that there is no biological reason to put an upper limit on the relative humidity (RH) in animal barns (Sallvik, 1979; Bruce, 1981; Owen, 1982). At high temperatures, increasing humidities make it difficult for swine to evaporate enough water to keep cool. However, controlled experiments have consistently shown that animal performance is not adversely affected by high humidities so long as the animals are housed near their lower critical temperatures. Building designers have suggested, then, that the maximum relative humidity must be less than about 90%, but only to prevent condensation on barn walls and ceilings.

EFFECT OF HUMIDITY ON PIG PRODUCTION

Temperature (°F)	Change in RH From	To	Daily Gain	Feed/Gain
10 - 24	45	90	NE	NE
28	30	80	down 16%	up 21%
33	20	80	down 29%	up 21%

NE = no effect

Morrison et al, 1966

Recent research from Britain (Webster, 1982) with dairy calves, however, has shown that the survival of airborne organisms is increased for relative humidities exceeding 80% at 15°C. At lower humidities, the organisms apparently dry out and either die or lose their ability to initiate disease. The researchers also have shown that P. haemolytica seeded in the lower respiratory tract of calves was only able to colonize when the calves were kept in an environment where the RH exceeded 80%.

The biological basis for establishing a lower bound on RH is not well defined. Researchers working with humans (Green, 1985) have shown that the incidence of respiratory disorders in school children may be reduced by maintaining relative humidities of at least 50%. Perhaps this effect is related to a drying out of the upper respiratory tract which, when healthy, provides a screening mechanism to remove harmful particles from the air before they reach the lungs.

In the absence of conclusive evidence concerning humidity in pig barns, to be on the safe side relative humidities should be kept between 50 and 80%.

Manure gases

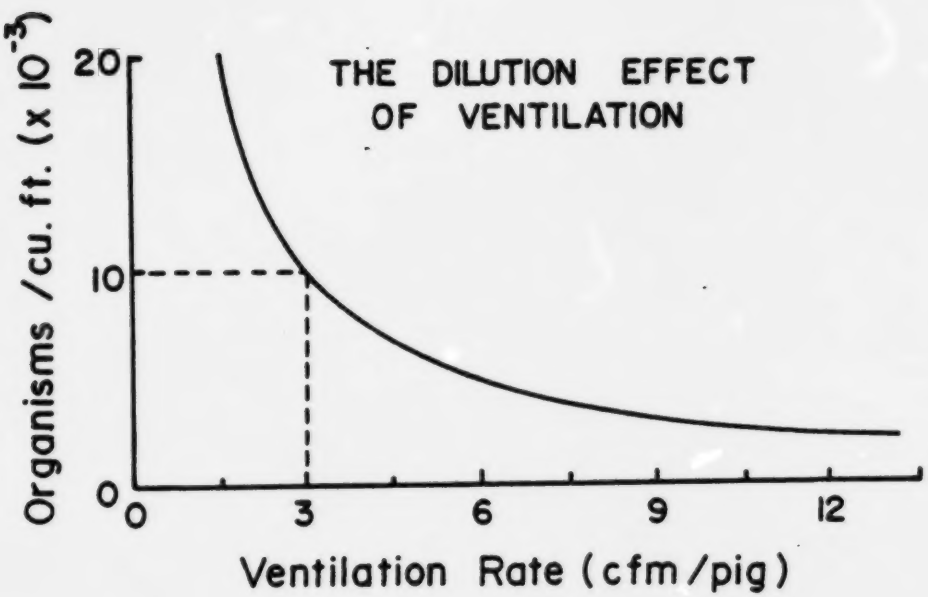
It has been common practice in some European countries to base ventilation rates on maintaining carbon dioxide (CO_2) levels below some cutoff value, say 0.2% (Sallvik, 1979). There is no evidence, however, that levels of CO_2 much higher than .2% would have any harmful effects on swine. It might be argued that CO_2 levels will parallel the levels of other more harmful gases such as ammonia (NH_3) and hence will serve as an indicator of the adequacy of

ventilation. Unfortunately, studies have shown that CO_2 production in animal barns is mostly related to the level of feed intake whereas NH_3 production is mostly related to manure management practices. Therefore controlling CO_2 levels could not be counted upon to also control other harmful manure gases.

A more appropriate gas upon which to base minimum ventilation is NH_3. This gas is likely harmful to swine at levels of 50 ppm and is most certainly a source of severe discomfort to barn operators at levels of about 25 ppm. Unfortunately, there is not enough information currently available to predict how much ammonia is produced in different swine barns. Furthermore, inexpensive sensors to detect the level of ammonia in a barn are just now being developed and probably need more extensive evaluation before widespread adoption on swine farms.

Airborne Organisms

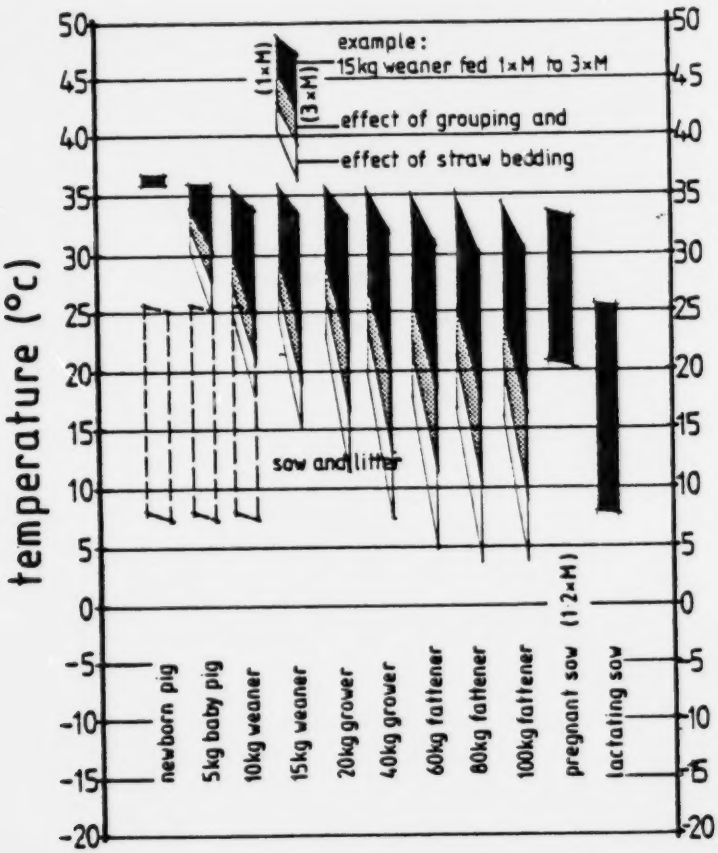
A typical value for airborne organism count in a swine weanling room operated at the minimum ventilation rate might be 10,000 organisms per cubic foot. Because ventilation of barns is a dilution process, every doubling of the ventilation rate will only reduce the organism count by 50%.



Given that supplemental heat already is being added to the swine weanling room, the question to be seriously pondered is whether it will pay to heat twice as much ventilation air just to drop the organism count from 10,000 to 5,000 organisms per cubic foot. Might it be more economical, in fact, to reduce the animal stocking density, or to try to remove the organisms by air filtration?

Temperature

The minimum winter ventilation rate must control noxious compounds in the air but the rate cannot be specified independently of barn temperature. For all farm animals there exists a range of temperatures over which productivity is unaffected. The temperature range is very small for young piglets but is quite large for grower-finisher pigs being fed ad libitum. The lower and upper limitss of the acceptable temperature range, called the lower and upper critical temperatures, respectively, are also affected by feed energy intake, air velocity, floor type, group size, and humidity (at the upper end only).



Optimum temperature ranges for pigs (Baxter, 1984)

During times when supplemental heat must be supplied to maintain a barn temperature above the LCT, economic sense dictates that the barn be kept as close to the LCT as possible. Similarly, during the summer, the optimum barn temperature will be closer to the UCT than to the LCT.

During wintertime, heat loss from a pig barn due to ventilation far exceeds heat loss through the building surfaces. Therefore, there is much interest in reducing minimum ventilation rates and in operating barns cooler.

VENTILATION OF A FEEDER BARN FOR OUTSIDE TEMPERATURE OF -35°C

	Barn Temperature	
	10°C	20°C
Maximum Ventilation Rate to achieve heat balance with no supplemental heat (L/s.pig)	2.2	1.4
Relative humidity (%)	55	80

Consider the example of a barn housing 400 pigs, 60 kg average when the outdoor temperature is -35°C. Assuming pens with partially slatted floors, 15 pigs per pen, and ad-libitum feed intake, the LCT for these pigs will be about 10°C and the UCT will be about 25°C. Using the best available data for heat and moisture production of grower-finisher pigs (Bruce, 1982) and assuming no supplemental heat is available, the allowable minimum ventilation rates and the resulting RH levels are as shown in the table. Allowing the barn temperature to drop to 10°C from 20°C meant that the ventilation rate could be increased by 55% and the relative humidity was reduced from 80% to 55%. Of course, the levels of the other noxious airborne contaminants also would be reduced by the increase in ventilation. Alternatively, calculations will show that it will take a ventilation rate of 2 L/s.pig and about 15 kW of heat to drop the relative humidity of the 20°C barn to 55%.

The one contaminant that could increase in the cooler barn is dust. Evidence points to increased pig activity at cooler temperatures with a consequent increase in dust production (Feddes et al, 1982). Overall dust levels also may increase due to the lower room RH.

EFFECT OF FEEDING METHOD AND ROOM TEMPERATURE OF ENVIRONMENTAL QUALITY

	Ad. libitum	Restricted	22°C	25°C
RH	68	69	73	64
Dust (particles/L)				
<5 um	1270	2306	2211	1366
>5 um	31	88	71	48
NH (ppm)	6-26	4-20	4-26	6-20

Feddes et al, 1982

The above comparison between a warm and a cool room was a bit theoretical but there have been many studies showing the same sort of results. Several studies also have shown that substantial energy savings can be realized by reducing nighttime temperatures in weanling and grower-finisher barns. Nighttime temperature setbacks by as much as 10°C do not seem to adversely affect the productivity of healthy pigs and indeed the cooler nighttime temperatures may actually be preferred by the pigs. It is important, though, that the nighttime set back be gradual rather than occuring over just a few minutes.

Substantial energy savings will be realized by using nighttime temperature setbacks. Operating the barn cooler all the time will save even more energy and will not hurt the performance nor the feed/gain ratio of healthy pigs providing the temperature is above the lower critical temperature. In fact, performance may be enhanced and disease reduced by increasing ventilation rates.

A word of caution is in order, though. Sick pigs, especially those that are off feed, will not be able to cope with the cooler barn temperatures. Pigs that are off feed and struggling to keep warm cannot quickly adjust body temperature to combat infection (Straw, 1984). Barn operators must be prepared to provide a warmer environment for a sick pig or pigs off feed. Cooler barns, then, require better management and closer observation of pigs.

COMPARISON OF TWO FARROWING ROOM TEMPERATURES

	EXPERIMENT #1		EXPERIMENT #1	
	Cold	Warm	Cold	Warm
Farrowing Room Temperature (°C)	15	27	15	25
Litters farrowed	14	23	12	12
Live pigs/litter	9.7	10.9	8.7	8.7
Average birth weight	1.39	1.31	1.41	1.38
% weaned	84.9	91.2	86.2	92.0
Avg. weaning weight	7.7	7.0	7.3	7.5
Creep feed/pig (kg)	.8	.9	.59	.83
Feed/sow (kg)	125.3	123.0	134.9	131.0

Nienaber et al, 1985

EFFECT OF REDUCED NIGHTIME TEMPERATURES ON WEANLING PIGS

	Control	Reduced Nocturnal
No. of pigs	192	192
Temperature:		
day time	86 - 74	86 - 74
night time	86 - 74	68 - 60
ADG (lb/day)	.73	.77
Feed/Gain	1.55	1.58
Pigs removed from test	1	5
Utility costs during four 5 week trials	$554.40	$382.50

Shelton and Brumm, 1985

EFFECT OF DAILY TEMPERATURE CYCLING ON PERFORMANCE OF 40 - 90 Kg PIGS

	Daily Temperature Variations(°C) ±.5	±5	±10
No. of pigs	64	32	32
Gain (kg/d)	.66	.67	.63
Feed (kg/d)	2.27	2.24	2.19
Feed/gain	3.44	3.31	3.51

Morrison et al, 1975

GETTING THE CORRECT MINIMUM CONTINUOUS VENTILATION

While tables have been published suggesting the minimum ventilation rates required in swine barns, several factors combine to cause some uncertainty as to the correct minimum ventilation rate for any particular barn:

(1) Barns differ with respect to the rate of production of water vapor and noxious gases.

(2) Manufacturer's fan specifications are not always accurate given the conditions under which a particular fan is installed.

(3) In some cases, the number of animals in a room will change. Especially in all-in-all-out facilities, the weight of the pigs in the room changes with time. Both factors mean that the minimum ventilation rate must change.

(4) Economics of heating barns continuously changes. The operator may want to change his mind about how much heat he is willing to put into a barn and hence about the level of relative humidity or ammonia that he is prepared to accept.

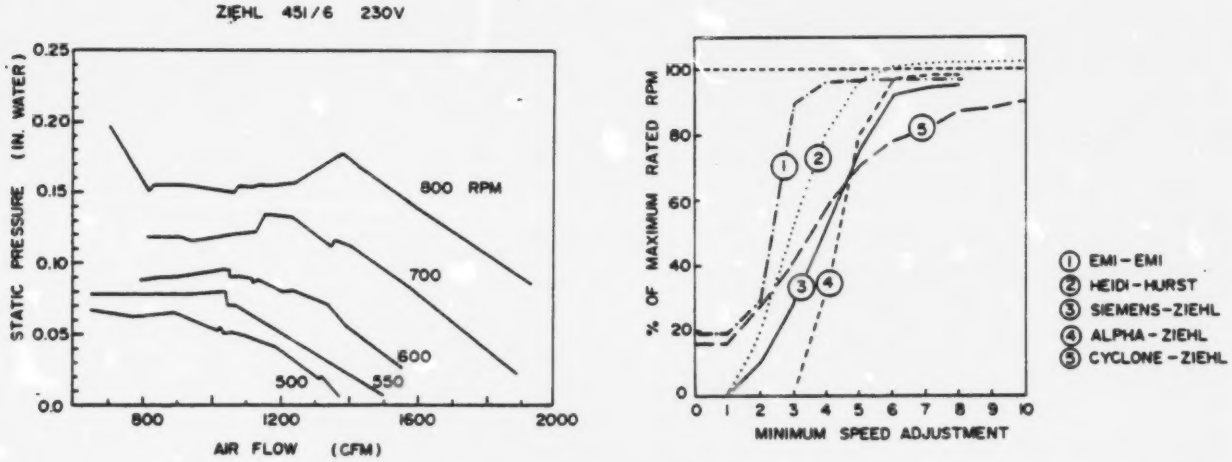
Therefore, the minimum ventilation capacity that is installed needs to come with some flexibility for adjustment.

RECOMMENDED MINIMUM VENTILATION RATES FOR SWINE BARNS

Gestation barn	10 cfm/sow
Farrowing barn	15 cfm/sow and litter
Weanling barn	2 cfm/pig
Grower-finisher barn	3 cfm/pig

Canadian Farm Building Code, 1977

At the same time that the minimum ventilation rate needs to be adjustable, the minimum amount of air needs to be provided continuously and reliably. Variable speed fans operating on variable speed or multi-speed controllers generally do not provide a consistent minimum ventilation rate. Rather, the amount of air delivered by the fans when operating below 50% of full-rated speed will be very subject to major fluctuations due to changing windspeed and direction. The result will either be the wasting of heat (when ventilation rates are too high) or unhealthy environment (when the ventilation rates are too low). Furthermore, variable speed fan controllers exhibit a very non-linear relationship between the set position of the minimum speed knob and the speed that is attained. Reliably setting a precise speed between 30 and 70% of full-rated speed is impossible. Multispeed controllers may overcome this second problem with variable speed fans but not the first.



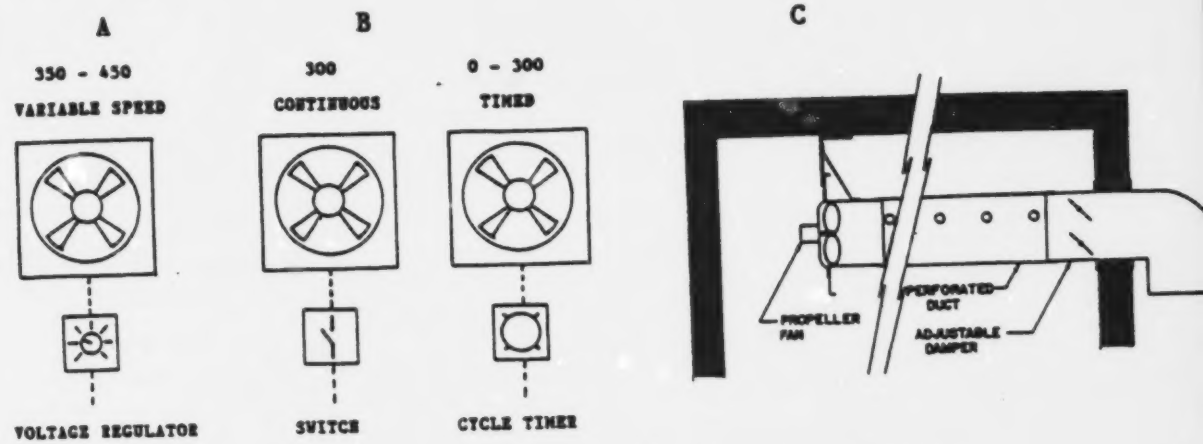
Two reasons not to use variable speed fans for minimum ventilation (a) At pressures normally encountered in barns (.05-.1 inches of water), air delivery at low speeds is very erratic; (b) It is difficult to precisely set the fan speed in the range of 30 to 70% of full speed.

Three recommended alternatives for achieving an adjustable minimum ventilation rate are as follows:

1. Buy a variable speed fan that is rated to deliver 20% more air than you think you need. Wire the fan directly but incorporate a manual voltage regulator. This way, you can adjust the ventilation rate by +20% without changing the fan. You can also change the minimum rate manually depending on the outside temperature, small changes in animal numbers, during washing of floors, etc. Avoid operating the fan at less than 80% of its full rated speed.

2. Install a fan that will deliver about 25% less air than you think you need, but wire in an additional fan (same size) on a manually-adjustable cycle timer. In this way, you can increase the effective minimum ventilation rate by increasing the percentage of time that the second fan operates. A single fan on a cycle timer is not recommended because moist air will back up into air inlets during fan off times.

3. Install a combination exhaust-recirculation system (Bayne 1985). This system is recommended especially for small rooms. The fan on the end of the perforated duct should have a capacity about three times greater than the maximum expected minimum ventilation rate. Manual adjustment of the exhaust damper will change the proportion of air that is exhausted from the building compared to the proportion of air that is recirculated.



Three Adjustable Minimum Ventilation Systems

Given that you have installed a system, such as those just described, that enables you to manually adjust the minimum ventilation rate, how do you decide at what level to run the fans? Remember that adjustment of the minimum ventilation rate is critical only during the heating season. There are two good criteria to use:

1. Barn humidity

If the barn is too moist (RH above 80%), increase the continuous minimum ventilation rate. Note though that increasing the ventilation rate will lower the room temperature unless enough supplemental heat is available. In an unheated finisher barn, if the barn is too moist, increase the minimum ventilation rate and allow the barn temperature to decrease. If you can't accept colder temperatures, then install some heating capacity. It is probably healthier for both the operator and the pigs to be a bit cooler than to have a dripping, wet and smelly barn.

Some people would like to use humidity control for their barn ventilation, but a good humidistat is still not available at a reasonble cost. Even if you decide to install one of the existing commercial humidistats, you will only be able to use the humidistat to control the heaters, not the fans. In an unheated barn, humidistat control does not work during very cold weather.

Barn operators are encouraged to purchase an inexpensive instrument for measuring humidity. These cheap instruments cannot be left in the barn, but they can be used on a periodic basis to check on humidity levels. The formation of condensation used to be a good indicator of relative humidities that were too high. However, with well insulated barns and well-mixed airspaces, condensation may not begin to appear until RH values as high as 90 or 95% are reached. Such high humidities should be avoided for healthy pigs and barn operators.

2. Smell levels

Every barn operator will have a personal interpretation of what level of odor can be tolerated in a pig barn. There is a reasonable amount of evidence that the levels of most gases in the barn become intolerable to the operator before becoming a problem for the pigs. If you find yourself hating to go into a barn, or cutting back on the amount of time you spend in a barn, then odor and gas levels are too high for both you and the pigs. The only good solution is to increase the ventilation rate. Again note, that the barn will be cooler at the higher ventilation rate unless you have sufficient heating capacity to keep up with the increased ventilation heat loss.

Some barn operators will consider wearing face masks when working in pig barns. For those with allergies, that may be the only practical solution. But a trend towards wearing of masks by the entire industry would be a mistake. We must reduce gas and dust to tolerable levels rather than protect ourselves against harmful conditions. In a similar way, Reburn is quoted by Leece (1975) as having wondered,

"if humans would have had antibiotics in their feed in the Middle Ages, perhaps flush toilets would have never been invented".

Let us strive to keep gases and dust in our pig barns at levels that can be tolerated by healthy pigs and operators without the need for special protective equipment.

UNDER FLOOR AIR EXHAUST

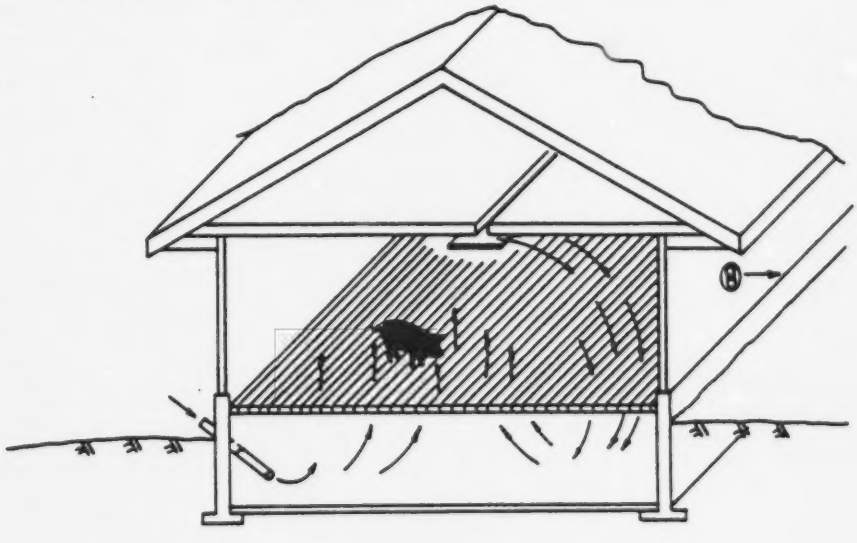
There have been many claims, and some circumstanial evidence, that an improved animal environment can be attained by exhausting air from the manure pits in slatted or partially-slatted floor barns. However, the scientific evidence is too scarce and nonconclusive to predict whether under-floor exhaust systems are cost efffective.

Any air movement from a manure pit up through a slotted floor will bring manure gases and water vapor into the animal-occupied space. The possibility of air movement up through the floor exists for three reasons (Bruce, 1975).

1. Jets of air, either directly from fresh air inlets or indirectly due to forced or natural air mixing in the animal space, may strike the floor and pass through. Air from under the floor then is passed up through the floor at some other location.

2. Heat produced by an animal lying or standing above the floor causes a natural upward air current in the vicinity of the animal. This upward air current will suck air upward through the floor.

3. Where an air inlet (usually unplanned) exists below floor level, a net upward exchange of air will occur.



The third reason for air exchange from the pit to the animal space is likely to be the most important. Especially during emptying of manure pits when outside covers have been removed, there will be a substantial inflow of fresh air through the pit and into the barn. Special attention should be given to ensuring that there are no places for fresh air to leak directly into a manure pit from outside.

Some authors and producers wishing to promote underfloor exhaust have appealed to our "intuition" by suggesting that it is obvious that exhausting from the pit will prevent any manure gases from entering the airspace. What is the evidence?

Feddes and McQuitty (1973) experimented with a slatted-floor beef barn in Alberta. Air was exhausted either from below the slats or from near the ceiling. Their data show that the air exhausted from the barn from below the slats contained higher levels of ammonia and water vapor. However, the room air quality measured in terms of RH, ammonia and CO concentrations, was not significantly different for the two exhaust locations. How could this be? It would appear that even with the exhaust below the slats, there is substantial air movement upward through the floor. This air movement probably is due to the normal mixing action of air currents within the animal space.

ROOM AIR QUALITY IN A BEEF BARN WITH HIGH OR LOW LEVEL EXHAUST OUTLETS

	Straw		Slatted floor	
	Lower Exhaust	Upper Exhaust	Lower Exhaust	Upper Exhaust
NH_3 (ppm)	12	13	15	17
CO_2 (ppm)	2500	2500	2150	2150
Water Vapour (% RH)	64	66	67	63

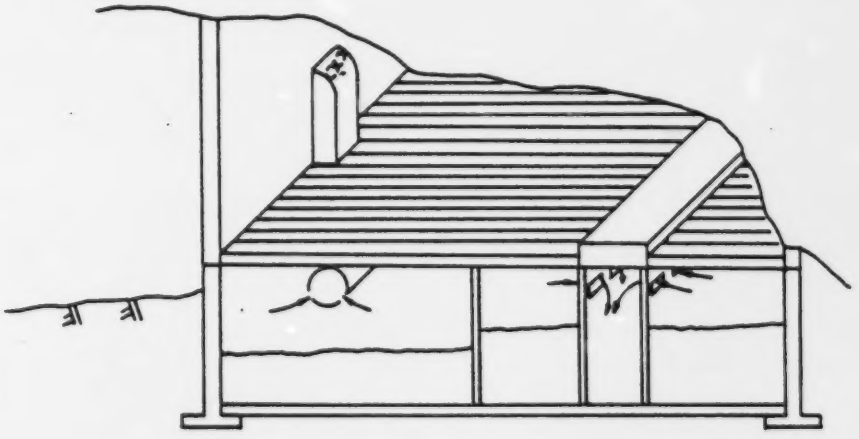
Feddes & McQuitty, 1973

GAS REMOVAL FROM A BEEF BARN FOR HIGH VERSUS LOW LEVEL EXHAUST OUTLETS

	Straw		Slatted floor	
	Lower Exhaust	Upper Exhaust	Lower Exhaust	Upper Exhaust
NH_3 (outlet-inlet, ppm)	8	8	17	12
CO_2 (outlet-inlet, ppm)	800	850	870	900
Water vapor (lb/an-day)	35.2	3.2	37.2	32.8

Feddes & McQuitty, 1973

So you want to install a pit exhaust regardless of the evidence. Just installing a duct from a sidewall fan down to one point at floor level cannot be expected to be effective. Instead, a perforated duct should be installed in the manure pit through which air is extracted uniformly from along the pit. One alternative is a perforated rigid plastic duct. Another more expensive alternative is a separate concrete air duct with holes at the top connecting to the manure pits. In either case, get help from an engineer to make sure the duct is big enough and to get the holes correctly sized and spaced for uniform air extraction.



A concrete or rigid plastic duct, with correctly spaced holes, connected to an exhaust fan will help to minimize manure gas problems. A single point extraction as from a ducted sidewall fan is not likely to be effective.

FILTERS AND AIR CLEANERS

Increasing ventilation rates will be an inefficient way to reduce levels of dust and airborne organisms in pig barns. Reducing the rate of production of these contaminants should be considered before any other control measures are contemplated. If dust and organism levels are too high and there is no practical way to reduce the production of the contaminants, filters may be a worthwhile possibility.

Experiments conducted in England (Prichard et al, 1981) with calf barns demonstrated the drastic reductions in aerial bacteria concentration that can be obtained with filters, and suggested that disease problems would be reduced. U.S. experiments (Hillman et al, 1985) have confirmed a reduction in the incidence of respiratory disease in calves reared in rooms equipped with air filters.

There are no technical reasons why filters cannot be used in pig barns to remove dust and organisms (Owen, 1982). Self-contained filter units could be installed in any barn. Filter racks could very easily be installed in barns with existing recirculation fans.

The problems are increased capital and operating costs for the filters and extra fans, and the high maintenance requirement. Self-cleaning filters are very expensive. Other types of filters will need weekly or more frequent cleaning. The swine industry can expect to see more widespread use of filters over the next few years.

Gas levels too can be reduced by chemical removal of the gases from the airspace. Ammonia scrubbers are technically possible but are expensive and are relatively ineffective if improperly maintained (Ryan et al,1983, Koelliker et al, 1980). Water removal (dehumidification) is possible too, but reduction of humidity by chemical dehumidification, followed by reduced minimum ventilation rates, can be expected to lead to more problems with high gas levels.

Airspace disinfection for removal of airborne pathogens will be effective but will be very expensive. The disinfection procedure would need to be repeated very frequently to have any lasting effect on organism levels.

TOWARDS HEALTHY PIGS AND WORKERS - A CHECKLIST

1. Ensure that your barns are well-insulated (walls, ceiling and foundations) and that the vapor barrier is intact. Be sure all doors fit tightly to minimize unwanted air infiltration.

2. Be especially sure that fresh air cannot enter the barn through the manure pit.

3. Store manure inside barns for only a very short time, preferably less than 10 days but never for more than 30 days.

4. In new barns, keep ceilings high. Consider a ceiling height of about 10 feet.

5. Minimze the number of pigs per pen and the number of pigs per room.

6. Plan for all-in-all-out room operation whenever overall size of the enterprize is big enough to make room sizes practical.

7. Install manually-adjustable minimum continuous ventilation.

8. Maintain the room relative humidity between 50 and 80%; use a portable hygrometer to regularly check relative humidity.

9. In unheated buildings, use good judgement in adjusting the minimum ventilation rate. Often, it will be preferable to operate the barn drier and cooler rather than warm, moist and smelly. Make provision to supply spot heat to sick animals housed in a cool barn.

10. If you find yourself spending less time in your barn because you hate to go in there, take steps to improve the environment. Most people should use face masks and personal filters only as a short-term solution.

11. Install some supplementary air mixing or air-recirculation, especially in small rooms and always in heated rooms and in rooms with decked pens. Regularly check, using a common thermometer, that the temperature of the airspace is the same in all pens. If the temperature is uniform, so too will moisture and gas concentrations be uniform.

12. Consider the use of below-slat air exhaust, but be sure to extract the air into a properly designed perforated duct running along the length of the manure pit. A single point exhaust from the manure pit will not likely be of much benefit.

13. In very dusty rooms, consider the use of air filters. Weanling rooms would likely benefit most from filtration. Do not install a filtration system if you don't intend to clean it.

14. Install an alarm system to warn of out-of-range temperatures.

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PROBLEM SOLVING WITH COMPUTERIZED SWINE RECORDS

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Manitoba Swine Seminar
Windsor Park Inn
Winnipeg, Manitoba
February 19 - 20, 1986

INTRODUCTION

Swine production and swine practice are becoming data intensive. The main trends are toward more active data collection and the integration of records interpretation and analysis into a package of management consultation services. Just as veterinarians now interpret complete blood counts, serum chemistry profiles, or radiographs they will begin to offer interpretation of performance records in a diagnostic context.

There are several major computerized production and health recording systems for swine herds now available. One, developed at the University of Minnesota and used in approximately 150 swine herds,[a] is incorporated into this article as a model.

A STRUCTURED APPROACH TO PROBLEM SOLVING

Data are only useful when placed in the context of particular decisions or problems. A critical component of a computerized recording system is a design that enhances one's ability to identify problems, analyze problems, and solve problems by evaluating tentative diagnostic hypotheses. Production and health monitoring systems developed for swine and dairy enterprises have not been truly useful for consultants or farmers. One of their most significant limitations arose because herd performance was summarized by averages which could not be disaggregated. To search for a problem's possible causes, summary measures must be dissected or partitioned into their individual components; otherwise, the source may remain hidden in the overall summary statistic.

Problems or opportunities are recognized when actual performance deviates from expected or targeted levels. Analysis defines problems as specifically and in as much detail as possible. For example, measures of reproductive performance can be cross-classified on epidemiological criteria, e.g. parity, breed, location, housing type, or other management factors. One can then analyze the

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[a] PigCHAMP[R]

effects of these factors on overall herd performance.

The process of using data for the overall management of a swine enterprise is continuous: set targets (planning), monitor actual performance, identify and investigate deviations, and revise expectations in the light of biologic and economic feasibility. Since the process is data intensive, it requires a computer-based system that provides rapid availability of comprehensive and accurate records of production, health, and costs and returns.

PRODUCTIVITY ANALYSIS

Problem-solving with records rests on the development of a problem/opportunity analysis tree diagram (Figure 1). This tree structure aids problem analysis by breaking overall summary statistics into their components and isolating the potential causes of a problem. For example, pigs weaned/sow/year (PW/S/Y) can be broken into three primary components: litters/sow/year (L/S/Y), liveborn average, and pre-weaning mortality. Since only these components directly influence PW/S/Y, a problem with low PW/S/Y must be due to inadequate performance in one or more of these components.

Taking this analysis a step further (moving down the tree), L/S/Y is a function of performance in open females (eligible females not bred) and bred females.

Unproductive Days in Open Females

Unproductive or lost days in open females come from weaned sows that are culled without being bred or from open gilts that spend too much time in the gilt pool. Lost days in open sows are measured by the number of days from weaning to culling and in open gilts by the number of days from entry to culling. Although no target figures exist for these measures, analysis has shown (Table) that sows culled for reproductive failure remain in the herd for an average of 128 days from farrowing to culling (Stein and Dijkhuizen 1985). Approximately 30% of sows are culled for reproductive failure, and anestrus accounts for about one-third of these culls (Stein and Dijkhuizen 1985). Open gilts spend between 15 and 135 days in the gilt pool prior to breeding and 30% are culled between herd entry and first farrowing, thus accumulating more unproductive herd days (Stein 1985). Thus, one step in trouble-shooting a problem with L/S/Y would be to investigate performance in open females. A reproductive monitoring system should provide some measure of the number of days from weaning to culling in open sows and days from entry to first service and entry to culling for open gilts. An effective way to stimulate action is through action lists for sows weaned and not yet served and gilts entered but not served.

Unproductive Days in Bred Females

Unproductive or lost days in bred females accumulate from the time of farrowing to the subsequent farrowing or culling. These lost days are a function of age at weaning, weaning to first service interval, farrowing rate, and gestation length. The sum of all these days equals the farrowing interval, which heavily influences the overall L/S/Y.

Gestation length

Gestation length is fixed; there is very little one can do to influence this except with prostaglandin-induced farrowing. The value of induced farrowing, however, does not come from a one or two day reduction in average gestation length.

Age at weaning

Age at weaning is under the producer's control and is dependent on the facilities and production scheduling. It can be influenced, and most farms with average weaning ages over 30 days should be encouraged to reduce their weaning age by moving toward continuous farrowing or tightening up their farrowing groups. Although it may be unwise under present economic conditions to build more farrowing space, the most that a single farrowing house can be expected to support would be four groups. A major challenge to consultants is to sit down with producers and reorganize their breeding and farrowing groups. However, one must be careful not to reduce weaning age to the point of diminishing returns. Weaned pigs must be old enough to tolerate the nursery conditions on the farm. A poor nursery means that the average pig must be older and heavier at weaning. Also, recent research has shown that on some farms and for certain breeds weaning at less than 26 days negatively influences the litter size the next time a female farrows. This is especially true for first litter gilts. Sows may farrow 0.1 pig less for each day that weaning age drops below 26 days (Clark and Leman 1985).

Weaning-to-first service interval

Weaning to first service interval is influenced by season, by nutrition during lactation, by lactation length, by post-weaning management, and by parity of the sow. Most herds should target a 7 to 8 day interval with 85% of sows bred within one week of weaning. In Table 4, notice that the worst herd averaged a 19 day interval with 45% bred within a week of weaning. Experience has shown that this can be improved by reducing lactation length (especially in gilt litters), by increasing feed consumption during lactation, by providing intimate boar and sow group exposure after weaning, by providing *ad libitum* feeding post-weaning, and by providing straw bedding to the just-weaned sows awaiting service in the breeding barn. A reproductive monitoring system should highlight the weaning to first service interval and percent bred within 7 days. Attacking this problem in herds with low L/S/Y can significantly improve productivity. This is another place for an action list that reports ID numbers for sows weaned but not yet served. Parity 1 females (first-litter gilts) will have longer intervals from weaning to breeding, averaging 10 - 15 days and 60% - 80% bred within one week. Therefore, herds with a high percent of gilts can expect to have a longer weaning to first service interval.

Farrowing rate

The farrowing rate is a function of the return-to-service rate, the non-pregnancy rate (at 35 - 45 days), the abortion rate, the failure-to-farrow rate, and the culling and death rate within breeding groups. A more detailed discussion is not possible here, except to note that the pattern of changes in these component rates can provide significant diagnostic information. For example, a seasonal pattern looks like this: an increase in repeat services in

July and August, an increase in negative pregnancy checks in August and September, and an increase in failures-to-farrow (sows that pregnancy test positive or do not return to heat, look pregnant, may "belly-down" and actually have milk, but do not farrow) in December (Stein et al. 1984). If this pattern occurs at a time not consistent with season (for example, an increase in failures-to-farrow in June), then one must consider either infectious disease or mycotoxins. Zearalenone (estrogenic F2 toxin) will produce exactly the same pattern, but it may occur outside of typical seasonal limits or may occur continuously.

The most significant effects on farrowing rate come from multiple matings and multiple services in the breeding group. A multiple mating is two or more breedings (inseminations) during one heat period. A multiple service is a sow that has returned to heat one or more times and is being bred again. We have solved many farrowing rate problems with the report illustrated in Table 3. Notice that on this farm parity 0 females (gilts) mated once had a 52.2% farrowing rate and farrowed 1.6 fewer live pigs than gilts mated twice. Across all females, those mated once had a 59.3% rate and farrowed 0.5 fewer live pigs than females mated twice. Also, notice the significant parity effects: as parity increases, the farrowing rate and litter size also increase until parity 7 or greater, especially in females with two matings during a heat period.

Data from England and confirmed in Minnesota analysis shows that the farrowing rate for sows served once (no return to heat) averages 80%, while for sows served twice (one return to heat) the farrowing rate averages 62%. Sows served three times (two returns to heat) farrow at a 51% rate. Therefore, herds that breed sows which have returned to heat twice or more, have a high percentage of gilts, and have a low percentage of multiple matings are almost guaranteed to have a low farrowing rate.

Liveborn average

Liveborn average is a function of the total litter size and the average number of pigs born dead. Litter size is influenced by genetics, by parity, by the parity distribution (the percent of animals in a herd by parity), by age at weaning (discussed above), by infectious disease (parvovirus), and by the weaning-to-breeding interval (discussed above under age at weaning). Analysis from 18 herds (Stein and Dijkhuizen 1985) shows that across herds and breeds the parity effect on liveborn litter size is as follows (cf Table):

Parity 1:	9.4 live
Parity 2:	9.8 live
Parity 3 - 6:	10.6 live
Parity 7 or >:	9.9 live

Obviously, herds with a skewed parity distribution, e.g. a high percentage of gilts or older parity groups (7 or greater) will have a lower liveborn litter size. Litter size in herds with these parity distributions will not change until the herd age structure is changed. Changing herd age structure requires a new focus on culling management. We have set up directed culling strategies on some farms to shift their parity distributions and increase the percentage of highly productive parity groups 3 - 6. Thus, a record system must have the

capability of recording and analyzing culls by reason and by parity.

For example, notice the herd parity distribution in Table 2. This report summarizes performance by parity from a confinement farrow-to-finish operation in southern Minnesota with Landrace/Large White/Yorkshire home-raised gilts and Farmer's Hybrid terminal sires.

There would be at least four rule-outs for low litter size in this herd: genetics, parity distribution effects, parvovirus, and age at weaning. Since total and live litter size averages were lower than expected across all parity groups, poor genetic potential must be one of the primary rule outs. Note also how the herd age structure caused parity groups 1 and 2 to have an inordinate effect on the herd average. These two groups farrowed 96 of the 195 litters in the period (about 45%). Thus, the largest population groups (Parity groups 1 and 2) had the smallest litter size and made up the largest percentage of all farrowings. As long as the first two parities make up such a high proportion of the farrowings, litter size will not improve.

The next step would be to go to the farm and perform a diagnostic investigation, concentrating on the affected populations, i.e. gilts and Parity 2 sows. Serologic profiles for parvovirus may be needed, and gilt management would have to be assessed carefully (age at breeding, weight at breeding, pen mating vs. hand mating, boar exposure, housing after breeding, nutrition, etc.). The power of defining a problem as specifically as possible <u>before</u> going to the farm is that instead of observing all animals and hoping that a problem will be obvious, one need only investigate problem groups and compare them with unaffected groups.

The plan for this farm would be the following: (1) Change the herd age distribution. Determine the reasons for culling and shift culling pressure away from gilts. (2) Increase the age at weaning or do not breed on the first heat after weaning in Parity 1 females (first-litter gilts). (3) Examine gilts and change gilt management if necessary. Test gilts for porcine parvovirus exposure prior to breeding and vaccinate or expose by feeding back manure or mummified pigs. Assess the age and size of gilts at first breeding. Breed gilts on their second estrus. Provide boar exposure with vasectomized boars in the gilt pool. (4) Improve the genetic system by better gilt selection, by purchasing F1 gilts, or by developing an on-farm nucleus herd (a possibility on farms of this size or smaller).

Pre-weaning mortality

The number of pigs weaned is a function of the number of pigs born live and the pre-weaning mortality. Pre-weaning mortality is influenced by environment (barn, room, and pen location effects), by lactation management (cross-fostering and nurse sows), by parity, and by the amount and responsibility of the labor resource going into the farrowing house.

Analysis from herds on our recording systems shows that there is a 5% to 10% reduction in total pre-weaning mortality associated with raised farrowing crates compared with solid floor concrete farrowing. There are also significant room effects when controlling for the type of flooring.

Most producers are very adept at lactation management, particularly in their use of nurse sows. Some producers push the farrowing house by breeding more females than the crates will support, weaning the extra sows on the first day following farrowing, and fostering the extra pigs on to the remaining sows. Other producers with large litter sizes have had success by weaning their heaviest pigs (7 to 14 days of age) into raised plastic tubs with heat lamps and providing milk replacer along with small amounts of a high quality starter diet. Most problems with cross-fostering come from mixing a wide variation in age, e.g. fostering 9 day pigs into a 1 day old litter.

Analysis also shows that there are parity effects on pre-weaning mortality. Parity groups 2 through 5 have the lowest levels of lactation death loss even when adjusting for cross-fostering. Gilts have slightly higher levels, but the pigs at highest risk of death in the farrowing house are those in litters nursed by Parity groups 6 or greater. These groups may have pre-weaning mortality levels of 20% or more, even when the overall herd averages 12%.

With the labor input available on most U.S. herds, it is difficult to push pre-weaning mortality below about 12%. It can be done but requires someone to have responsibility and accountability for the farrowing house, and to devote more time to observation and intervention at and just after farrowing.

DESIRABLE FEATURES IN A COMPUTERIZED RECORDING SYSTEM

Data Recording

Data recording on farms must be simple, practical, and convenient; it must complement manual methods currently in use. The recording system should require only a minimal amount of data that is of direct use, based on individual animal records rather than herd averages or summary data. For example, all analyses shown in this article are based on recording only farrowings, weanings, breedings, and culls or deaths. However, a system need not require that services be recorded; the producer merely loses some problem-solving information if they are not recorded. Data collection requirements must be flexible and adaptable to allow for a time of gradual accomodation to the recording system. Design must be based on the assumption that errors in data collection will occur, especially those of event dates and animal identification. Data should be validated at the time of entry, and validation should be based on multiple levels of error detection built into the program, rather than relying on the judgement and skill of the data entry operator.

For long-term trend analysis, the program must be capable of maintaining lifetime event histories of all animals that entered and left the herd. However, the program should not store empty data fields in sow records; otherwise, it will exceed the limitations of microcomputer data storage.

Lists and Reports

Calculations must be precise, especially regarding the animals to be included or excluded from the analysis and the time period over which the calculation is made. No report or list should require more than 5 to 10 minutes to

generate, although this depends somewhat on the size of the herd, the type of analysis, the length of the time period being analyzed, and the technical limitations of the hardware. Reports and lists must be flexible and satisfy the needs of many different advisors and users: veterinarians, farm owners, farm managers, farm staff, accountants, bankers, and specialist extension agents. Reports must be simple to read and interpret. All significant overall measures of production should be presented in a single table. Past performance measures must be available for comparison with current performance levels to assess trends over time.

The Process of Using a Recording System

Lists and reports from a computerized recording system must focus on three areas: daily management activity, monitoring current performance and trend analysis, and diagnostic profiles.

Reports and summaries which aid daily management include sow cards, action lists, and sow performance summaries. Producers make three major decisions on a daily basis: which litters to notch for replacement females, whether to cull a sow after weaning or send her to the breeding barn, and which gilts to select from the finishing floor. An example of a report that aids daily management would be single-line lifetime summaries of individual sow performance on a list of sows due to farrow to aid decisions on identifying potential replacement females at farrowing.

Trends can only be assessed with a minimum of 12 months data, and preferably 18 to 24 months. Current performance should be monitored on a daily, weekly, or monthly basis (depending on herd size) and compared with long-term trends, ideally on the same page of a report. Problems or opportunities can be identified by noting how current performance varies from long-term trends and how it compares to targets or expected levels of performance for the herd.

To aid trend analysis and the monitoring of current performance, a one-page report which shows a cluster of fundamental performance measures, similar to the one shown in Table 1, can be used. This report shows at a glance the herd's productivity level (measured by PW/S/Y) and the major components of overall productivity. A number of yearly periods or rolling averages could be printed to assess long-term trends, or monthly performance over 12 months with a year summary column could be printed to assess current performance in the light of the longer term. Using the tree structure discussed above, it is easy to see why this herd has achieved top productivity. The herd produced an average 22.7 PW/S/Y because (1) it averaged 2.3 L/S/Y and (2) 10.5 pigs born live and (3) 8.6% pre-weaning mortality. The herd produced 2.3 L/S/Y because it had a weaning-to-frist service interval of 6.0 days with 90.2% of sows bred within one week of weaning, a 90.4% farrowing rate, and a 28.1 average age at weaning. The farrowing rate was high because 86.9% of females were mated twice or more (multiple matings percent). Litter size was high because of genetic potential (Cambrough F1 gilts were purchased) and multiple matings.

The key aspect of this report is that any disease, management problem, or other constraint on productivity should be expressed in these figures. If a disease causes a significant problem, one or more of these measures should reflect the disease effect by showing up as a lower than expected performance

level. The implication is that if a disease does not cause a measureable effect on a performance figure, then it can be ignored. Conversely, if a disease cannot be identified yet performance is low, then the problem must be explored and will most likely be due to inadequate management, genetics, or nutrition.

Once a problem or opportunity has been identified at this overall or summary level, then diagnostic reports can be used to dissect out the components and isolate the problem at a deeper level. The diagnostic process is based on following out the productivity tree to its deepest level (as discussed above) and then analyzing for the factors which influence each individual component, e.g. farrowing rate, pre-weaning mortality, liveborn litter size, etc.

Ideally, there should be diagnostic profiles which analyze overall performance for parity effects (Table 2 is an example), for breed effects, for sire and dam effects, and for origin effects. A recording system should be able to analyze individual performance measures (farrowing rate, litter size, pre-weaning mortality, etc.) for the major factors that influence these measures, e.g. parity, number of matings (e.g. Table 3), number of services, location, etc. Indivdual boar performance should be analyzed by farrowing rate, liveborn averge, and average number of pigs born dead. It is important, however, to also control for possible confounding in the analysis. For example, the average parity of the females bred to individual boars must be accounted for since boars bred primarily to gilts can be expected to have lower liveborn averages than boars bred to older parity females. Finally, there should be reports to analyze the reasons for culling and death that can be used to redirect culling strategy and shift herd age distributions.

Targets or Expected Levels of Performance

Since the process of problem solving rests on recognizing problems as deviations from expected performance levels, one must have subjective or objective expectations in mind when analyzing herd records.

Table 4 summarizes the performance of nine farms that use the University of Minnesota recording system. The first column (AVERAGE) is the mean performance across all herds; Column 2 (BEST) is the best performance achieved in each performance category across the herds (the column does not summarize figures from the best herd, just the best in each category); Column 3 (WORST) is the worst or lowest level of performance achieved in each category; and the final column (TARGETS) presents realistic performance targets that herds have achieved consistently. Since each herd that a veterinarian services is unique, appropriate expectations must be determined in the light of individual circumstances. However, these figures will at least provide general expectations for Upper Midwest swine breeding herds.

CONCLUSIONS

The swine industry and the veterinary profession have discovered the power of record analysis rather than simple record keeping. A danger, however, is information overload, in which report after report spew from a printer with no distinction in terms of importance. Analysis is most useful when it is

directed by a systematic, structured approach; problem identification, problem analysis, and records review should proceed just as a systematic physical examination.

A major benefit of recording systems arises from the ability to evaluate one's recommendations, treatments, or management changes. This evaluation focuses on the bottom line of results rather than activity; it allows us to build experience based on results.

There is a distinction between herd health programs and professional problem solving (Problem Oriented Population Medicine). Herd health programs are policies and procedures, e.g. the timing, selection, and use of vaccinations and treatments, the nutritional formulations and selection of basemix or premix, and the genetic policy for the farm. Professional problem solving rests on professional interpretation of data, examination of populations rather than individuals, and formulating population-based differential diagnoses, rule outs, and treatment plans.

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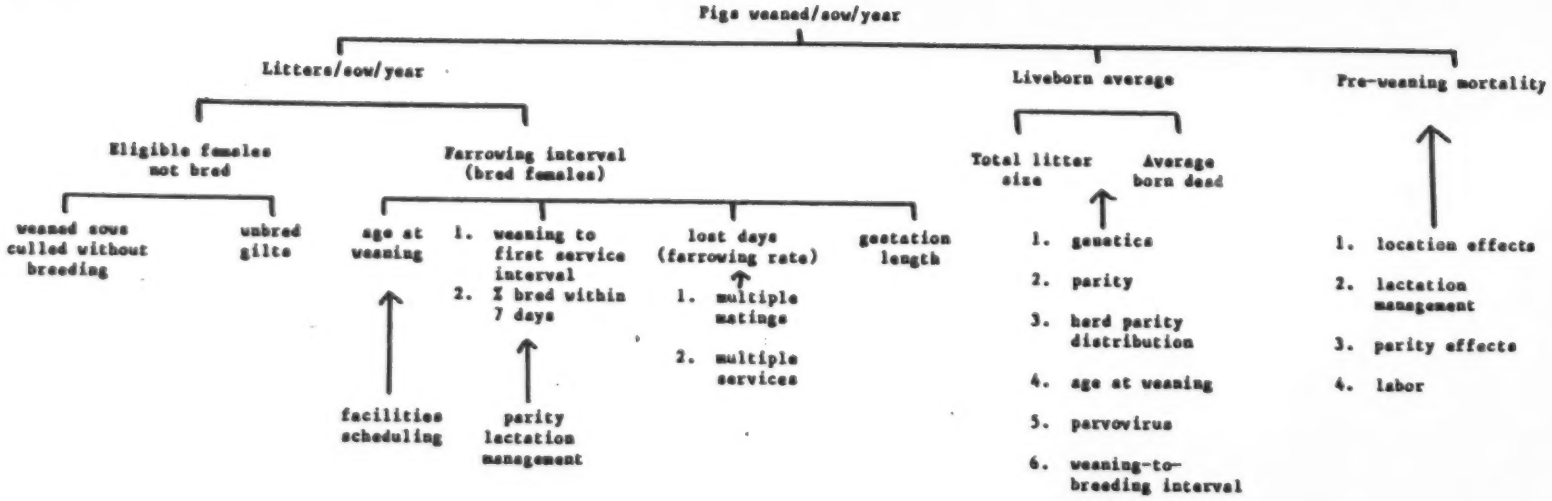
Productivity Analysis Tree



PERFORMANCE MONITOR
1 SEP 84 - 31 AUG 85

PigCHAMP 1.2
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Printed: 10 JAN 86

	SEP 84 AUG 85
BREEDING PERFORMANCE	
Total females served	413
Females served 1st service	394
Females served repeat service	19
Percent repeat services	4.6
Percent multiple matings	86.9
Weaning - 1st service interval	6.0
Percent sows bred by 7 days	90.2
Entry - 1st service interval	15
FARROWING PERFORMANCE	
Number of sows farrowed	367
Ave parity of farrowed sows	3.3
Total pigs born alive	3851
Average total pigs per litter	11.4
Average pigs born alive/litter	10.5
Average pigs born dead/litter	0.9
Percent born dead	8.0
Percent mummies	2.8
Litters less than 7 born live	40
Percent < 7 born live	10.9
Average birth weight	.
Farrowing rate	90.4
Average gestation length	115
Farrowing interval	149
Litters / mated female / year	2.30
WEANING PERFORMANCE	
Number of litters weaned	382
Total pigs weaned	3614
Average pigs weaned per litter	9.5
Pre-weaning mortality	8.6
Average weaning weight	18.0
Average age at weaning	28.1
Average Ohio SPI	214
Pigs weaned/mated female/year	22.7
POPULATION	
Ending female inventory	150
Average parity	2.9
Average female inventory	160.7
Gilts entered	88
Replacement rate	54.8
Sows and gilts culled	84
Culling rate	52.3
Ave parity of culled sows	3.6
Sow and gilt deaths	2
Death rate	1.2
Ending boar inventory	35

Table 1.

PARITY DISTRIBUTION REPORT
31 DEC 83 - 30 DEC 84

PigCHAMP 1.
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	PARITY 0	1	2	3 - 6	7+	ENTIR HERD
BREEDING PERFORMANCE						
Total females served	38	51	46	64	45	244
Females served 1st service	31	47	45	63	44	230
Females served repeat service	7	4	1	1	1	14
Percent repeat services	18.4	7.8	2.2	1.6	2.2	5.7
Percent multiple matings	52.2	94.4	97.8	98.5	100.0	89.5
Weaning - 1st service interval	.	10.4	5.8	4.6	4.4	6.3
Percent sows bred by 7 days	0.0	83.7	88.9	98.4	95.6	92.1
FARROWING PERFORMANCE						
Number of sows farrowed	0	59	44	72	46	221
Total pigs born alive	.	504	373	660	472	2009
Average total pigs per litter	.	9.1	8.9	9.5	11.2	9.6
Average pigs born alive/litter	.	8.5	8.5	9.2	10.3	9.1
Average pigs born dead/litter	.	0.5	0.5	0.3	1.0	0.5
Percent born dead	.	5.8	5.1	3.2	8.5	5.5
Percent mummies	.	1.7	0.8	0.7	0.8	1.0
Litters less than 7 born live	.	9	12	11	3	35
Percent < 7 born live	.	15.3	27.3	15.3	6.5	15.8
Average birth weight	.	3.3	3.6	4.0	3.2	3.6
Farrowing rate	.	.	83.0	83.7	85.2	92.5
Average gestation length	.	116	115	114	115	115
Farrowing interval	.	.	154	149	149	150
WEANING PERFORMANCE						
Number of litters weaned	0	54	47	68	46	215
Total pigs weaned	.	396	368	560	370	1694
Average pigs weaned per litter	.	7.3	7.8	8.2	8.0	7.9
Pre-weaning mortality	.	19.2	11.8	11.8	17.0	14.8
Average weaning weight	.	10.5	11.1	11.6	11.3	11.2
Average age at weaning	.	20.2	18.7	20.4	20.6	20.0
Average Ohio SPI	.	160	163	164	169	164
POPULATION						
Ending female inventory	9	32	18	35	15	109
Average female inventory	36.3	24.9	20.6	22.3	21.2	125.3
Sows and gilts culled	15	6	4	5	9	39
Sow and gilt deaths	0	0	0	0	0	0

Table 2.

BREEDING PERFORMANCE
1 JUL 84 - 31 DEC 84

PigCHAMP 1.2
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NUMBER OF MATINGS REPORT

	PARITY 0	1	2	3 - 6	7+	TOTAL
ONE MATING						
Number of services	23	14	14	32	3	86
Known service results	23	14	14	32	3	86
Returned to service	8	3	3	11	0	25
Repeat service rate (%)	34.8	21.4	21.4	34.4	0.0	29.1
Number farrowed	12	10	10	16	3	51
Farrowing rate (%)	52.2	71.4	71.4	50.0	100.0	59.3
Ave. total born	9.1	11.4	11.2	11.9	7.3	10.7
Ave. born alive	8.3	10.7	10.1	10.3	6.0	9.6
Ave. born dead	0.8	0.7	1.1	1.6	1.3	1.1
litters < 7 live	3	0	3	2	1	9
TWO MATINGS						
Number of services	60	39	44	111	13	267
Known service results	60	39	44	111	13	267
Returned to service	11	3	11	16	5	46
Repeat service rate (%)	18.3	7.7	25.0	14.4	38.5	17.2
Number farrowed	48	31	31	89	7	206
Farrowing rate (%)	80.0	79.5	70.5	80.2	53.8	77.2
Ave. total born	11.2	12.2	11.8	10.9	8.9	11.2
Ave. born alive	9.9	11.1	10.6	9.9	7.3	10.1
Ave. born dead	1.2	1.1	1.1	1.0	1.6	1.1
litters < 7 live	6	3	2	12	3	26
THREE OR MORE MATINGS						
Number of services	9	3	0	3	1	16
Known service results	9	3		3	1	16
Returned to service	0	0		0	0	0
Repeat service rate (%)	0.0	0.0		0.0	0.0	0.0
Number farrowed	9	3		3	0	15
Farrowing rate (%)	100.0	100.0		100.0	0.0	93.8
Ave. total born	12.4	13.7		12.0		12.6
Ave. born alive	11.6	13.0		11.3		11.8
Ave. born dead	0.9	0.7		0.7		0.8
litters < 7 live	0	0		0		0

Sows selected for the breeding performance report were served in the report period.

All rate calculations are based on records where the service results are known. Sows with services as last events are not included in the denominator.

Table 3.

Table 4. Performance analysis from 9 farms that use the PigCHAMP recording system. AVERAGE = mean performance across the 9 farms; BEST = best performance by category (not the best farm of the 9); WORST = lowest performance level by category; TARGETS = consistently achieved performance levels for above-average herds.

	AVERAGE	BEST	WORST	TARGETS
BREEDING PERFORMANCE				
Repeat service rate (%)	12.0%	5.0%	25.0%	< 10%
Weaning - 1st service interval	7.0	5.4	19.0	< 6 days
Percent sows bred by 7 days	87.0%	94.3%	45.0%	> 85%
Multiple matings percent	75.0%	90.0%	40.0%	> 80%
FARROWING PERFORMANCE				
Total pigs per litter	11.0	12.1	9.2	> 10.5
Born live per litter	10.0	11.5	8.7	> 10.0
Born dead per litter	1.0	0.6	1.2	< 0.8
Percent born dead	8.1%	6.0%	10.7%	< 8%
Percent mummified	1.6%	0.6%	2.7%	< 1.5%
Percent litters less than 7 live	11.7%	1.3%	18.5%	< 12%
Average birth weight	3.3	3.7	2.9	> 3.4
Farrowing rate	81.0%	89.9%	62.0%	> 85%
Litters / mated female / year	2.03	2.28	1.50	> 2.10
WEANING PERFORMANCE				
Pigs weaned per sow weaned	8.7	10.5	7.6	> 9.0
Pre-weaning mortality	13.9%	8.6%	18.2%	< 12%
Average weaning weight	14.2	16.7	11.2	----
Average weight per day of age	0.528	0.620	0.400	> .600
Average age at weaning	----	19.4	33.5	> 22 days
Average Productivity Index (Ohio)	184	203	163	> 185
Pigs weaned / mated female / year	17.6	20.0	13.1	> 18.5
POPULATION				
Culling rate	59.8%	50.5%	82.8%	??
Sow death rate	2.5%	0.88%	11.0%	< 1.5%
Replacement rate	67.8%	49.1%	81.2%	> ??

PIG CHAMP

Computerized Health

and

Management Program

PigCHAMP is a swine herd record keeping system developed at the University of Minnesota. It provides a valuable management and diagnostic aid for swine producers and veterinarians. The program is currently available for purchase, or for use through the University of Minnesota mail-in service bureau.

The PigCHAMP Software

The PigCHAMP program allows you to enter reproductive data into the system in a natural "event-oriented" manner. As it is entered, the data is tested for logical consistency, so many errors can be caught and corrected immediately. Once the data is entered, it can be used to produce a variety of management lists and diagnostic reports. PigCHAMP reports distill data into useful information and present it in a structured format, so users do not become victims of information overload.

Alternatives: Purchase or Mail-In Service Bureau

Producers who would like to use the University of Minnesota service bureau can send their data to the University, on a weekly or monthly basis, and receive reports back within four working days.

Producers and veterinarians can purchase the program to run on their own microcomputers.

Software Cost

The PigCHAMP software is available in three types of purchase agreements. 1) A single herd license costs $250 and can only be used for one herd. 2) A research cooperator license also costs $250 but can be used on any number of herds. Research cooperators agree to provide anonymous copies of their production data to the University of Minnesota for research purposes. 3) A commercial license, available for $500, is a multiple herd license with no obligation to share data.

Purchasers of all license types will receive the software diskettes, a 250 page indexed user manual, and 12 months of consultation and update privileges. Annual maintenance contracts can be purchased after the initial year for $100.

Hardware Requirements

PigCHAMP runs on PC-DOS and MS-DOS microcomputers with two disk drives and 256K of RAM. This includes the IBM PC, XT, AT, and PC Jr. It runs on IBM compatibles including Compaq, Zenith 140 and 150 series, and Leading Edge. It also runs on most noncompatible MS-DOS computers including Vector and DEC Rainbow. It does not run on the Apple II or CP/M computers.

Individual Sow History

The foundation of the PigCHAMP system is the individual sow lifetime history. All of the reported measures and analyses are calculated from events recorded for each sow.

PigCHAMP is event-oriented. We have defined the things that may happen as sows move through a cycle, and each thing is called an "event". A sow may ENTER the herd, FARROW, FOSTER some pigs on or off, WEAN, be SERVICED, or be REMOVED from the herd (death, cull, sale, or transfer). Other events occur less frequently, like PREGNANCY EXAM, ABORTION, SOW WEIGHT, SOW CONDITION SCORE, etc. A group of these events makes up a sow cycle, from one farrowing through to the next. Figure 1 is an example of a sow record.

Each electronic sow record grows to accommodate the events in a sow's history: sows with few events have short records, and as more events pile up a sow's record expands like an accordion to make room for the new events and cycles. There is no limit on the number of events that any sow can have in her record. There is no limit to the total number of sow records that can be stored by PigCHAMP.

HISTORY
FARM:

PigCHAMP 1.2
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Printed: 31 OCT 85

Sow: R100 Parity: 3 Status: DIAGNOSED PREGNANT
Birth date: Sire: Dam: Breed:

PARITY	DATE	EVENT	EVENT DATA
0	26 JUN 84	SERVICE	Boar: 015B
	27 JUN 84	SERVICE	Boar: 015B
1	17 OCT 84	FARROW	Alive: 12 Stillborn: 0 Mummies: 0 Weight:
	17 OCT 84	FOSTER	4 pigs off
	8 NOV 84	WEAN	Pigs weaned: 11 Litter weight: 130.0
	12 NOV 84	SERVICE	Boar: P880B
	13 NOV 84	SERVICE	Boar: Y47B
2	6 MAR 85	FARROW	Alive: 6 Stillborn: 1 Mummies: 0 Weight:
	6 MAR 85	LOCATION	Barn: Room: Pen: B23
	6 MAR 85	FOSTER	5 pigs on
	8 MAR 85	PIG DEATHS	Died: 2 Reason: SPRADDLE LEG
	29 MAR 85	WEAN	Pigs weaned: 10 Litter weight: 129.0
	2 APR 85	SERVICE	Boar: 09B
	3 APR 85	SERVICE	Boar: 09B
3	23 JUL 85	FARROW	Alive: 10 Stillborn: 0 Mummies: 0 Weight:
	23 JUL 85	LOCATION	Barn: Room: 5 Pen: 15
	25 JUL 85	PIG DEATHS	Died: 1 Reason: LAID ON
	14 AUG 85	WEAN	Pigs weaned: 11 Litter weight: 121.0
	18 AUG 85	SERVICE	Boar: Y51B
	19 AUG 85	SERVICE	Boar: 010B
	23 SEP 85	PREG. EXAM	Result: POSITIVE
	23 SEP 85	LOCATION	Barn: GS Room: Pen: 15

THE BASE MENU

The base menu is the centerpiece of the system. All procedures are entered from this menu, including data entry, reports and lists, record management procedures and farm creation or selection programs. The advantage of using a base menu is that you avoid passing through page after page of sub-menus to get in or out of a program. In PigCHAMP, you enter each program from the base menu, and when you leave each program you go back to the base menu.

The base menu looks like this:

PigCHAMP FARM: -------- 6 AUG 84

SYSTEM COMMANDS	DATA ENTRY	MANAGEMENT LISTS	PROBLEM ANALYSIS
ARchive data	ADd events	ACtion lists	BOAR Performance
BAckup farm	Edit mode	BOAR Usage	BReeding performance
CReate farm	DELETE Records	CURrent status	CULling analysis
DELETE Farm		Gilt selection	FARM comparison
SELect farm		History	FARRowing rate
REOrganize	MISC	SOw performance	PArity distribution
RESTore farm		SUMmary cards	PErformance monitor
	HElp		PIg deaths
	PRinter		REMoval reasons
	Quit		SERvice efficiency
	Write a text file		SUBset comparison

SYSTEM commands are the housekeeping commands. CREATE and SELECT are used to start a new herd or to use herds that have already been started. CREATE starts the file for a new farm. If a farm data file already exists, then SELECT lets you tell PigCHAMP the farm you will be working with. Use BACKUP to make a backup copy of the farm data files. You must run RESTORE before a backup copy of the data file can be used as an original file. REORGANIZE eliminates any empty disk space between sow records, essentially reducing the size of the data file.

DATA ENTRY programs are used to enter data on individual animals (ADD EVENTS and EDIT MODE), or to physically remove individual records from the farm file (DELETE RECORDS).

MANAGEMENT LISTS and PROBLEM ANALYSIS REPORTS: These programs are used to produce all of the output from PigCHAMP.

MANAGEMENT LISTS let you create lists for management activity (action lists), for inventory control, for lifetime sow histories, for determining current status of animals, and for assessing sow productivity.

PROBLEM ANALYSIS REPORTS allow you to create production profiles and diagnostic reports for control and analysis of breeding herd performance, for problem identification, for problem-solving, and for monitoring trends.

PigCHAMP is designed to be flexible enough to be used by farmers, veterinarians, and other farm advisors; each person can create a set of reports tailored to his or her specific needs.

There are four **MISCELLANEOUS** commands. **HELP** displays a brief guide to the use of PigCHAMP on the screen. **QUIT** exits PigCHAMP to the operating system. **PRINTER** allows you to set the paper width before printing reports. **WRITE A TEXT FILE** opens the door to your data. Use this command to transfer your data out of PigCHAMP and into a spreadsheet such as LOTUS 1-2-3,® or database management programs such as dBASE III®, or into an integrated system such as Symphony® or Enable®.

ABOUT DATA ENTRY

The DATA ENTRY portion of the base menu lists the data entry and editing options.

There are two commands that can be used to enter data into PigCHAMP: ADD EVENTS and EDIT MODE. These two methods are variations on the same theme, but with important differences. ADD EVENTS is quicker but does not display the sow or boar record while you are working on it. EDIT MODE displays the animal's record while you work on it, and is the only way to make changes or corrections. Since these commands are internally linked, even after you select one of these methods, you can move freely between them.

EVENTS Used For Data Entry

PigCHAMP uses 17 events to describe the things that happen to a gilt, sow, or boar. You can record a lot of information by using all 17 events built into the program, but you only need to record farrowings, weanings, and removals to make the system work. This means that you can start small and grow into the system as your needs develop.

EVENT	DATA
1. ENTER	Parity: 0 Origin:
2. BOAR ENTRY	Origin:
3. PREG. EXAM	Result: POSITIVE
4. ABORTION	Comment:
5. FARROW	Alive: Stillborn: Mummies: Litter weight:
6. FOSTER	Pigs (on/off):
7. WEAN	Pigs weaned: Litter weight:
8. NURSE	Pigs nursed: (On/OFF)
9. REMOVE	Type: CULL Reason:
10. ADULT WT	Weight:
11. GENERAL	Comment:
12. SERVICE	Boar:
13. PIG DEATHS	Died: Reason:
14. LOCATION	Barn: Room: Pen:
15. LOST TAG	Comment:
16. RETAG	Parity:
17. LITTER ID	ID:

All events have the same structure. The event data differ depending on which event name is entered. First, you type in the id number, the date, and the event name. Next, you fill in the data fields (event data) for the specific event you have chosen to enter. The event structure for a farrowing is illustrated below:

Event Structure	Example
Id:	Y100
Date:	8/8/85
Event Name:	Farrow
Event data:	Born live: 10
	Stillborn: 1
	Mummified: 1
	Litter birthweight: 30

You are always required to enter id, date, and event name. But after that, you decide which fields to fill or leave blank under the event data.

ABOUT LISTS AND REPORTS

MANAGEMENT LISTS: A series of lists for supporting day-to-day management decisions.

Action lists:

Use the action lists command to produce seven lists you can use to check for missing data or for management action. The lists are: gilts entered but not served; pre-farrow vaccination; sows serviced requiring heat checks/pregnancy checks; sows due to farrow; sows farrowed but not weaned; sows weaned but not served; and sows not diagnosed pregnant.

Current status:

Use the current status command to print a list of all active sows in the herd. This list will include each sow's current parity, current status, most recent event and its date, and her current location (barn, room, and pen).

Gilt selection list:

The gilt selection list is used for gilt or boar selection. You can use this list to select gilts as they move out of the nursery or from the finishing floor.

List ID's:

Use the list ID's command to print seven different lists:

- All sows on the farm file
- Active sows only (sows which have not been REMOVED)
- REMOVED sows only
- Active boars only
- REMOVED boars only
- All boars on the farm file
- All sows and boars, active and removed

History:

Use the history command to print an exact copy of any sow or boar computer record, as it appears on the farm file. This will produce a listing of all EVENTS in her record.

Sow performance list:

The sow performance report has been designed to help you save time on a day-to-day management basis. This report can be used at weaning for your breeding decisions, at farrowing to decide which litters to ear notch, quickly look at sow's past performance and sort sows on various performance indices.

Summary cards

Use the summary cards command to print a sow card or boar record for any animal on file. This will produce a summary of performance to date which is abstracted from the computer record of events for the animal.

ACTION LIST
FARM:

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Gilts entered but not served

SOW ID	ENTERED	DAYS OPEN
154	24 APR 85	84
155	24 APR 85	84
156	24 APR 85	84
D1	25 APR 85	83

Sows served requiring heat checks / pregnancy tests

SOW ID	SERVED	21 DAYS	35 DAYS
82	14 JUN 85	5 JUL 85	19 JUL 85
77	15 JUN 85	6 JUL 85	20 JUL 85
22	16 JUN 85	7 JUL 85	21 JUL 85
418	16 JUN 85	7 JUL 85	21 JUL 85
69	16 JUN 85	7 JUL 85	21 JUL 85
87	16 JUN 85	7 JUL 85	21 JUL 85
6	17 JUN 85	8 JUL 85	22 JUL 85
79	17 JUN 85	8 JUL 85	22 JUL 85
150	18 JUN 85	9 JUL 85	23 JUL 85

Sows due to farrow

SOW ID	SERVED	DUE DATE	DAYS OVERDUE
394	11 FEB 85	6 JUN 85	41
136	16 MAR 85	9 JUL 85	8
539	16 MAR 85	9 JUL 85	8
131	22 MAR 85	15 JUL 85	2
24	25 MAR 85	18 JUL 85	
919	25 MAR 85	18 JUL 85	
J39	25 MAR 85	18 JUL 85	
50	26 MAR 85	19 JUL 85	
J26	27 MAR 85	20 JUL 85	

Sows diagnosed not pregnant

SOW ID	SERVED	NEGATIVE PREG CHECK
H100	11 MAY 85	22 JUN 85
H110	18 JUN 85	23 JUN 85

Pre-farrow vaccination

SOW ID	SERVED	VACCINATION DATE	DUE DATE
J26	27 MAR 85	17 JUL 85	20 JUL 85
130	1 APR 85	22 JUL 85	25 JUL 85
66	2 APR 85	23 JUL 85	26 JUL 85
98	2 APR 85	23 JUL 85	26 JUL 85
116	3 APR 85	24 JUL 85	27 JUL 85
J9	3 APR 85	24 JUL 85	27 JUL 85
19	8 APR 85	29 JUL 85	1 AUG 85
416	8 APR 85	29 JUL 85	1 AUG 85

Sows farrowed but not weaned

SOW ID	FARROWED	DAYS LACTATING
132	22 JUN 85	25
942	22 JUN 85	25
119	23 JUN 85	24
96	23 JUN 85	24
422	25 JUN 85	22
92	26 JUN 85	21
53	27 JUN 85	20
30	28 JUN 85	19
110	30 JUN 85	17

Sows weaned but not served

SOW ID	WEANED	DAYS OPEN
26	25 MAR 85	114
113	11 APR 85	97
32	11 APR 85	97
65	20 APR 85	88
63	29 APR 85	79
104	31 MAY 85	47
84	31 MAY 85	47

SOW PERFORMANCE LIST
FARM:

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STATUS: DUE TO FARROW

	LAST FARROW PERFORMANCE						AVERAGE PERFORMANCE					
SOW ID	FARROW DATE	PARITY	BORN LIVE	NET POST	PIGS WEANED	WEAN WEIGHT	FARROW INTER	BORN LIVE	PIGS WEANED	OHIO SPI	BOAR(S)	DUE TO FARROW
532											9738 5358	20OCT85
529											78 5358	22OCT85
466	29MAR85	3	13	0	13	252	167	11.0	11.3	270	4408 8228	23OCT85
547											9178	24OCT85
418	12MAY85	4	16	-5	9	173	170	14.8	10.5	262	4308 4408	25OCT85
472	10MAY85	2	14	-2	11	196	172	12.5	10.0	251	4408 8228	25OCT85
516	12MAY85	1	13	-2	9	138		13.0	9.0	216	78 1578	25OCT85
561											9178 9008	25OCT85
322	8MAY85	5	11	-1	9	161	168	11.6	10.2	197	5378 1578	26OCT85
325	10MAY85	5	10	1	11	184	179	9.8	10.6	219	9738 8228	26OCT85
450	9MAY85	3	14	-1	11	200	165	12.7	11.3	248	9738 5378	26OCT85
464B	12MAY85	3	10	2	12	200	186	9.0	10.7	218	5358	26OCT85
482	11MAY85	2	13	-2	11	187	172	12.5	11.0	243	8268	26OCT85
522	8MAY85	1	12	-1	12	150		12.0	11.5	208	78	26OCT85
525	18MAY85	1	11	2	9	115		11.0	9.0	197	78	26OCT85
483	15MAY85	2	9	2	12	150	167	10.5	11.0	214	4408 8268	27OCT85
487	31MAR85	2	10	2	11	185	178	7.5	8.0	223	4408	27OCT85
505	14MAY85	1	9	1	10	158		9.0	10.0	219	4308 4408	27OCT85
508	11MAY85	1	4	6	10	164		4.0	10.0	180	78	27OCT85
527	18MAY85	1	10	0	11	135		10.0	11.0	220	5358	27OCT85
544											9178	27OCT85
555											9008	27OCT85
428	3APR85	3	7	5	12	213	170	11.0	11.3	264	9738 1578	28OCT85
463	11MAY85	3	10	1	11	193	169	12.3	11.0	244	4408 8268	28OCT85
489	16MAY85	2	8	3	10	136	172	8.0	10.0	188	4308	28OCT85
517	18MAY85	1	12	-1	11	136		12.0	11.0	230	5378	28OCT85
465	4APR85	2	11	0	10	130	170	8.0	9.0	175	9738 4408	29OCT85
488	12MAY85	2	12	-1	10	153	167	11.0	10.0	211	5358	29OCT85
521	8MAY85	1	10	0	10	185		10.0	10.0	226	9738	30OCT85
559											78	3DEC85
574											9008	3DEC85
560											9008	5DEC85
471	20JUN85	2	7	4	11	211	210	5.5	10.0	227	9738 5378	6DEC85
103	20JUN85	4	11	0	10	200	166	10.5	10.3	253	4308 1578	7DEC85
285	19JUN85	6	10	1	11	175	166	9.2	9.3	224	8228 5358	7DEC85
334	26JUN85	5	6	5	9	147	181	12.2	11.4	222	78 1578	7DEC85
371	19JUN85	5	17	-5	10	162	168	14.2	10.4	250	9738 8268	7DEC85
372	21JUN85	5	15	-2	13	200	169	14.2	11.4	281	4408 8268	7DEC85
443	21JUN85	3	11	0	11	210	169	11.3	10.0	252	9738 5378	7DEC85
494	24JUN85	2	15	-4	11	174	174	14.5	11.0	328	4308 5378	7DEC85
503	18JUN85	1	14	-2	10	180		14.0	10.0	293	8268	7DEC85
543											9178	7DEC85

SOW SUMMARY CARD
FARM:

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Sow: B581 Parity: 7 Status: DIAGNOSED PREGNANT
Birth date: 3 MAY 82 Sire: 56B Dam: R102 Breed: HAMP

PARITY	0	1	2	3	4	5
Farrow date		11MAY83	29SEP83	20FEB84	8JUL84	24NOV84
Total born		10	11	15	10	11
Born alive		9	11	13	10	11
Stillborn		1	0	2	0	0
Mummies		0	0	0	0	0
Gestation length		115	115	113	113	113
Farrow interval			141	144	139	139
Ave birth weight						
Net fostered		-1		-5	2	-1
Weaning date		2JUN83	25OCT83	13MAR84	30JUL84	17DEC84
Pigs weaned		6	10	8	9	9
Age at weaning		22	26	22	22	23
Ave weaning weight		15.0	17.2	13.7	13.6	13.8
Ohio SPI		174	220	203	177	188
Nursed and weaned						
No. of services	1	1	1	1	1	1
First service	16JAN83	6JUN83	30OCT83	17MAR84	3AUG84	21DEC84
Last service						
Boar		Y583B	P882B	P478B	010B	Y51B

PARITY	6	7	AVERAGE
Farrow date	13APR85	31AUG85	
Total born	10	8	10.7
Born alive	7	8	9.9
Stillborn	3	0	0.9
Mummies	0	0	0.0
Gestation length	113	113	114
Farrow interval	140	140	140
Ave birth weight			
Net fostered		1	
Weaning date	6MAY85	23SEP85	
Pigs weaned	10	8	8.6
Age at weaning	23	23	23.0
Ave weaning weight	11.3	13.7	14.0
Ohio SPI	170	168	186
Nursed and weaned			
No. of services	1	1	1.0
First service	10MAY85	28SEP85	
Last service			
Boar	0282B	Y51B	

PROBLEM ANALYSIS REPORTS: These can be divided into two sections: Monitoring Reports and Problem Solving Reports.

OVERVIEW OF THE MONITORING REPORTS

Boar Usage Report

Use this report to monitor the actual number of matings for each boar in the herd. You have the option of specifying a daily, weekly, monthly, yearly, or any other time period, usage report.

Farm Comparison

The farm comparison report gives you a comparison of up to 12 farms. The report covers breeding performance, farrowing performance, weaning performance, and population changes. You can use the farm comparison to look at overall herd averages and to compare individual herds to the average for all the herds. This report actually gives a performance monitor, anonymously or with each herd identified by farm name or owner name, for up to 12 herds.

Farrowing Rate

Use the farrowing rate report to produce an analysis of the farrowing rate and non-farrowing rate for some previous time period, whether it is days, weeks, months, or years. The first section lists the number of sows in each breeding group (grouped by week of breeding or any other time period) and the number that currently remain pregnant in each group. The second section categorizes the "drop-outs" from each breeding group, by reason, e.g. return to heat, negative pregnancy check, and so on.

Parity Distribution

Use the parity distribution report to produce a parity distribution for breeding, farrowing, weaning, and population figures. This report draws on data for the entire herd to print the report. This report will give you the current age (parity) distribution for your herd. You also have the opportunity to monitor trends over time for any parity group(s) by specifying the number of periods to include in the report. The report then looks like a performance monitor, but each page concentrates on just one specific parity group.

Performance Monitor

Use this to produce the fundamental report of the PigCHAMP system, a report that monitors the performance over time for the four key areas of the breeding herd: breeding performance, farrowing performance, weaning performance, and the population. Rolling averages can also be reported using the Performance Monitor command.

PERFORMANCE MONITOR
1 JUL 84 - 30 JUN 85
FARM:

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	JAN 85	FEB 85	MAR 85	APR 85	MAY 85	JUN 85	JUL 84 JUN 85
BREEDING PERFORMANCE							
Total females served	35	28	39	30	42	28	415
Females served 1st service	35	27	38	30	40	27	387
Females served repeat service	0	1	1	0	2	1	28
Percent repeat services	0.0	3.6	2.6	0.0	4.8	3.6	6.7
Percent multiple matings	94.3	96.4	79.5	80.0	81.0	85.7	84.9
Weaning - 1st service interval	4.6	5.4	4.8	7.7	6.3	5.1	5.8
Percent sows bred by 7 days	100.0	90.9	100.0	84.6	85.2	94.4	91.1
Entry - 1st service interval	5	6	15	33	14	9	14
FARROWING PERFORMANCE							
Number of sows farrowed	33	25	32	36	30	30	373
Ave parity of farrowed sows	3.0	3.0	3.3	3.4	3.9	2.8	3.3
Total pigs born alive	341	274	344	377	291	327	3938
Average total pigs per litter	11.9	12.2	11.6	11.8	10.1	11.4	11.5
Average pigs born alive/litter	10.3	11.0	10.7	10.5	9.7	10.9	10.6
Average pigs born dead/litter	1.5	1.2	0.8	1.4	0.4	0.5	1.0
Percent born dead	13.0	9.9	7.0	11.5	4.3	4.4	8.6
Percent mummies	5.6	3.6	2.7	2.8	1.0	1.8	2.9
Litters less than 7 born live	3	0	5	3	5	3	36
Percent < 7 born live	9.1	0.0	15.6	8.3	16.7	10.0	9.7
Average birth weight	.	.	.	.	.	.	.
Farrowing rate	76.7	80.6	84.2	100.0	83.3	88.2	89.9
Average gestation length	115	115	115	115	115	114	115
Farrowing interval	151	153	149	151	144	148	149
Litters / mated female / year	2.45	2.03	2.36	2.74	2.22	2.29	2.35
WEANING PERFORMANCE							
Number of litters weaned	34	24	36	28	36	26	376
Total pigs weaned	319	238	357	263	345	244	3575
Average pigs weaned per litter	9.4	9.9	9.9	9.4	9.6	9.4	9.5
Pre-weaning mortality	11.9	6.2	7.9	7.3	7.4	4.2	9.1
Average weaning weight	16.3	17.6	16.6	17.0	18.0	19.6	17.7
Average age at weaning	24.4	29.0	26.4	27.3	28.1	30.0	28.1
Average Ohio SPI	210	219	214	209	212	224	211
Pigs weaned/mated female/year	24.2	19.5	26.2	20.1	25.5	18.6	22.6
POPULATION							
Ending female inventory	164	169	160	155	162	156	156
Average parity	2.6	2.5	2.6	2.8	2.7	2.7	2.7
Average female inventory	159.6	160.8	165.1	156.9	162.4	156.0	161.4
Gilts entered	6	12	0	0	15	9	82
Replacement rate	3.8	7.5	0.0	0.0	9.2	5.8	50.8
Sows and gilts culled	1	7	9	5	8	8	84
Culling rate	0.6	4.4	5.5	3.2	4.9	5.1	52.1
Ave parity of culled sows	3.0	4.1	3.8	3.4	3.0	5.9	4.0
Sow and gilt deaths	0	0	0	0	0	1	3
Death rate	0.0	0.0	0.0	0.0	0.0	0.6	1.9
Ending boar inventory	36	36	35	35	36	36	36

FARM COMPARISON
1 FEB 85 - 31 JUL 85

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	FARM A	FARM B	FARM C	FARM D	TOTAL
BREEDING PERFORMANCE					
Total females served	225	183	203	144	755
Females served 1st service	179	165	198	120	662
Females served repeat service	46	18	5	24	93
Percent repeat services	20.4	9.8	2.5	16.7	12.3
Percent multiple matings	87.0	56.0	85.9	73.2	76.4
Weaning - 1st service interval	17.4	8.2	5.8	5.3	9.0
Percent sows bred by 7 days	43.0	82.8	91.6	97.3	79.1
Entry - 1st service interval	.	73	15	10	36
FARROWING PERFORMANCE					
Number of sows farrowed	182	169	183	125	659
Ave parity of farrowed sows	1.1	3.0	3.4	2.6	2.5
Total pigs born alive	1880	1825	1933	1248	6886
Average total pigs per litter	11.0	11.9	11.4	10.9	11.3
Average pigs born alive/litter	10.3	10.8	10.6	10.0	10.4
Average pigs born dead/litter	0.7	1.1	0.8	0.9	0.9
Percent born dead ;	6.3	9.4	7.2	8.6	7.8
Percent mummies	2.0	1.9	2.4	1.2	1.9
Litters less than 7 born live	15	11	19	9	54
Percent < 7 born live	8.2	6.5	10.4	7.2	8.2
Average birth weight	.	.	.	.	.
Farrowing rate	87.1	91.4	91.5	.	89.9
Average gestation length	115	115	115	114	115
Farrowing interval	142	148	149	152	149
Litters / mated female / year	.	.	2.31	2.48	2.38
WEANING PERFORMANCE					
Number of litters weaned	150	169	192	123	634
Total pigs weaned	1468	1532	1840	1043	5883
Average pigs weaned per litter	9.8	9.1	9.6	8.5	9.3
Pre-weaning mortality	8.2	16.2	6.5	14.1	11.1
Average weaning weight	12.2	.	17.7	15.9	15.5
Average age at weaning	21.9	27.8	27.5	28.3	26.4
Average Ohio SPI	200	.	216	182	201
Pigs weaned/mated female/year	.	.	23.2	23.7	23.4
POPULATION					
Ending female inventory	194	159	155	141	649
Average parity	0.9	2.2	2.7	2.0	1.9
Average female inventory	180.4	170.7	160.1	120.2	631.5
Gilts entered	82	22	46	83	233
Replacement rate	45.4	12.9	28.7	69.1	36.9
Sows and gilts culled	18	33	48	17	116
Culling rate	10.0	19.3	30.0	14.1	18.4
Ave parity of culled sows	0.2	3.3	3.7	2.9	2.9
Sow and gilt deaths	4	7	1	2	14
Death rate	2.2	4.1	0.6	1.7	2.2
Ending boar inventory	6	9	36	10	61

PARITY DISTRIBUTION REPORT
1 JAN 85 - 30 JUN 85
FARM:

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	PARITY 0	1	2 - 6	7+	ENTIRE HERD
BREEDING PERFORMANCE					
Total females served	39	37	114	7	197
Females served 1st service	37	36	112	7	192
Females served repeat service	2	1	2	0	5
Percent repeat services	5.1	2.7	1.8	0.0	2.5
Percent multiple matings	90.2	78.9	85.3	100.0	85.6
Weaning - 1st service interval	.	5.4	5.8	3.9	5.7
Percent sows bred by 7 days	0.0	94.4	91.7	100.0	92.8
FARROWING PERFORMANCE					
Number of sows farrowed	0	42	134	10	186
Total pigs born alive	.	386	1475	93	1954
Average total pigs per litter	.	10.2	12.0	10.4	11.5
Average pigs born alive/litter	.	9.2	11.0	9.3	10.5
Average pigs born dead/litter	.	1.0	1.0	1.1	1.0
Percent born dead	.	10.0	8.1	10.6	8.6
Percent mummies	.	3.0	3.0	2.9	3.0
Litters less than 7 born live	.	5	12	2	19
Percent < 7 born live	.	11.9	9.0	20.0	10.2
Average birth weight	.	.	.	.	.
Farrowing rate	.	89.4	88.7	76.9	88.2
Average gestation length	.	115	115	115	115
Farrowing interval	.	.	150	147	149
WEANING PERFORMANCE					
Number of litters weaned	0	37	133	14	184
Total pigs weaned	.	343	1299	124	1766
Average pigs weaned per litter	.	9.3	9.8	8.9	9.6
Pre-weaning mortality	.	8.2	7.7	7.3	7.8
Average weaning weight	.	16.3	17.7	18.0	17.4
Average age at weaning	.	27.7	27.2	27.6	27.3
Average Ohio SPI	.	204	218	198	214
POPULATION					
Ending female inventory	24	28	100	4	156
Average female inventory	26.8	28.9	98.7	5.8	160.2
Sows and gilts culled	1	8	21	8	38
Sow and gilt deaths	0	0	1	0	1

OVERVIEW OF THE PROBLEM SOLVING REPORTS

Boar Performance Report

The boar performance report was designed to make comparisons between individual boars, and comparisons between individual boars and the overall herd average. Boar performance is measured by the percent returns to heat, farrowing rate, live litter size, and average number of pigs born dead.

Breeding Performance

The breeding performance report provides a summary of the farrowing results for all sows served during the time period. It also analyzes performance (farrowing rate and litter size) by the numbers of matings (1, 2, or 3) and the number of services (first, second, or third).

Culling Analysis

Use this report to discover the number and proportion of gilts entered or sows farrowed that were removed and whether they were removed from the farrowing house after weaning or after first service.

Pig Death Analysis

Pig death analysis is designed to give you diagnostic information on piglet deaths during lactation. Reasons for pig death are broken down by time, by parity of the sow, by age of the pig in days after farrowing, and by location.

Removal Reasons

Use the removal reasons report to examine the number and reasons for culls and deaths, over any period of time, by parity or by reason within parity.

Service Efficiency

Service efficiency analyzes performance for two different groups of sows: the sows served the first time after weaning and the sows returned to service during the report period. Both groups are selected for the report because they had a service during the report period. PigCHAMP calculates the days between the weaning and the first service after weaning. With this report, you can see distribution of services after weaning and see whether some groups of sows have very long intervals from weaning to first service. For returns to service, the same type of information is presented, with the average number of days to re-service also given.

Subset Comparison

The purpose of the subset comparison report is to let you use your own creativity to look at the performance in your herd. This report is especially useful for comparing genetic lines within a farm. The subset comparison is designed to provide an overall comparison of breeding performance, farrowing performance, weaning performance, and population by breed, sow ID number or name, origin, or sire. Up to 12 breeds, ID groups, origin groups, dam groups, or sire groups may be compared.

BOAR PERFORMANCE REPORT
1 JUL 84 - 30 JUN 85
FARM:

PigCHAMP 1.2
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Printed: 15 NOV 85

BOAR ID	TOTAL MATINGS	AVERAGE PARITY SERVICE	SINGLE BOAR SERVICES	NUMBER RETURNED		NUMBER FARROWED		AVERAGE BORN LIVE	AVERAGE BORN DEAD	AVERAGE PARITY FARROW
ALDEROSE	8	3.5	4	0	0%	4	100%	11.7	1.0	4.5
ATLAS	45	0.1	25	1	4%	9	36%	8.9	0.4	1.0
BORIS	97	1.0	49	4	8%	26	53%	10.6	1.3	1.7
CONAN	65	0.2	37	1	3%	13	35%	9.8	1.2	1.2
CURLY	14	0.7	9	0	0%	8	89%	6.1	0.1	1.8
HARDY	92	3.5	48	0	0%	36	75%	10.2	1.7	4.5
HERCULES	60	0.3	33	2	6%	10	30%	8.8	2.2	1.2
HUSKY	99	1.5	44	2	5%	24	55%	9.4	0.9	2.5
IVAN	51	4.4	27	1	4%	16	59%	9.6	1.8	5.9
LARRY	96	2.2	46	2	4%	29	63%	9.5	1.6	2.7
LAUREL	78	2.1	40	0	0%	27	67%	11.4	1.3	2.7
MOE	89	2.4	47	3	6%	28	60%	9.4	2.1	2.7
MRT	55	3.2	26	1	4%	23	88%	7.8	0.7	4.2
MUFFIN	61	3.1	28	1	4%	25	89%	11.3	1.7	4.2
PEABODY	85	1.0	41	2	5%	27	66%	9.4	2.1	1.8
RAYMOND	1	0.0	1	0	0%	0	0%			
ROCKY	43	2.3	21	2	10%	18	86%	8.2	1.7	3.3
SHERMAN	119	1.4	57	1	2%	37	65%	10.6	2.0	2.1
SOCRATES	60	4.9	25	0	0%	16	64%	11.0	1.0	5.8
TATE	30	4.7	15	0	0%	14	93%	10.6	2.1	5.8
TORRO	33	3.1	20	3	15%	16	80%	10.4	1.8	3.9
VINCE	32	4.8	16	2	13%	13	81%	10.5	1.5	5.9
TOTAL	1313	2.1	659	28	4%	419	64%	9.9	1.5	3.2

22 BOARS LISTED.

PIG DEATHS ANALYSIS
1 OCT 85 - 31 OCT 85
FARM:

PigCHAMP 1.2
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Printed: 3 DEC 85

PIG DEATHS BY AGE ANALYSIS

AGE:	NUMBER OF RECORDED PIG DEATHS 0 - 2	3 - 6	7 -14	15+	TOTAL
Litters					192
Pigs weaned					1816
Low viability	9	4	7	0	20
Laid on	12	34	18	6	70
Starvation	1	8	5	0	14
Scours	0	0	8	1	9
Savaged	0	0	0	0	0
Spraddle leg	3	2	0	0	5
Shaker	0	0	0	0	0
Deformed	0	0	1	1	2
Injured	2	1	0	0	3
Joint infection	0	0	2	2	4
TGE	0	0	0	0	0
Pseudorabies	0	0	0	0	0
Other	0	1	0	4	5
Unknown	0	1	0	0	1
Total recorded deaths	27	51	41	14	133
Deaths (born-weaned)					282

AGE:	PERCENT OF RECORDED DEATHS 0 - 2	3 - 6	7 -14	15+	TOTAL
Low viability	33%	8%	17%	0%	15%
Laid on	44	67	44	43	53
Starvation	4	16	12	0	11
Scours	0	0	20	7	7
Savaged	0	0	0	0	0
Spraddle leg	11	4	0	0	4
Shaker	0	0	0	0	0
Deformed	0	0	2	7	2
Injured	7	2	0	0	2
Joint infection	0	0	5	14	3
TGE	0	0	0	0	0
Pseudorabies	0	0	0	0	0
Other	0	2	0	29	4
Unknown	0	2	0	0	1
Total recorded deaths	20%	38%	31%	11%	100%

Litters selected for the pig death analysis were weaned in the report period.

ID COMPARISON REPORT
1 NOV 84 - 31 OCT 85
FARM:

PigCHAMP 1.2
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Printed: 3 DEC 85

	Y?	O?	W?	G?	ENTIRE HERD
BREEDING PERFORMANCE					
Total females served	152	202	190	165	815
Females served 1st service	139	180	174	151	737
Females served repeat service	13	22	16	14	78
Percent repeat services	8.6	10.9	8.4	8.5	9.6
Percent multiple matings	85.6	84.4	80.8	80.0	79.9
Weaning - 1st service interval	6.5	7.1	5.9	6.6	6.5
Percent sows bred by 7 days	87.1	83.9	92.8	90.1	88.5
Entry - 1st service interval	.	.	.	.	.
FARROWING PERFORMANCE					
Number of sows farrowed	156	185	158	141	683
Ave parity of farrowed sows	4.8	3.1	2.8	2.2	3.1
Total pigs born alive	1595	1781	1590	1353	6712
Average total pigs per litter	11.2	10.3	10.8	10.2	10.6
Average pigs born alive/litter	10.2	9.6	10.1	9.6	9.8
Average pigs born dead/litter	1.0	0.7	0.8	0.6	0.8
Percent born dead	8.5	6.4	7.2	6.1	7.2
Percent mummies	1.8	1.2	1.6	1.2	1.5
Litters less than 7 born live	9	28	14	14	75
Percent < 7 born live	5.8	15.1	8.9	9.9	11.0
Average birth weight	.	.	.	.	.
Farrowing rate	81.7	79.1	84.5	85.5	78.2
Average gestation length	113	114	114	114	114
Farrowing interval	151	152	148	149	150
Litters / mated female / year	1.91	2.05	2.19	2.28	2.01
WEANING PERFORMANCE					
Number of litters weaned	161	189	168	144	696
Total pigs weaned	1422	1703	1507	1278	6227
Average pigs weaned per litter	8.8	9.0	9.0	8.9	8.9
Pre-weaning mortality	14.9	11.7	13.6	14.7	13.6
Average weaning weight	.	.	.	.	.
Average age at weaning	28.5	27.9	27.5	27.4	27.8
Average Ohio SPI	.	.	.	.	.
Pigs weaned/mated female/year	16.8	19.1	21.2	21.7	18.4
POPULATION					
Ending female inventory	46	71	58	67	293
Average parity	5.4	3.3	2.9	2.2	2.9
Average female inventory	68.1	90.2	74.2	71.0	342.2
Gilts entered	0	31	36	34	176
Replacement rate	0.0	34.4	48.5	47.9	51.4
Sows and gilts culled	36	47	40	23	198
Culling rate	52.9	52.1	53.9	32.4	57.9
Ave parity of culled sows	4.7	2.4	3.1	2.3	2.4
Sow and gilt deaths	3	3	0	0	7
Death rate	4.4	3.3	0.0	0.0	2.0
Ending boar inventory	0	0	0	0	15

On December 2, 1985, the University of Minnesota sold their 100th copy of PigCHAMP, only 10 months after its original release.

The program is now being used in 17 states in the continental U.S., 5 Canadian provinces and 20 or more other locations worldwide.

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